FEBRUARY, 1952

VOLUME 127

No. 2

RAILWAY Mechanical and Electrical Engineer

Founded in 1832 as the American Rail-Road Journal.

Simmons-Boardman Publishing Corporation: James G. Lyne, President, New York; Samuel O. Dunn, Chairman Emeritus, Chicago; J. S. Crane, Vice-Pres. and Sec., New York; C. Miles Burpee, Vice-Pres., New York; John S. Vreeland, Vice-Pres., New York; H. H. Melville, Vice-Pres., Cleveland; C. W. Merriken, Vice-Pres., New York; John R. Thompson, Vice-Pres., Chicago; Wm. H. Schmidt, Jr., Vice-Pres., Chicago; Robert G. Lewis, Asst. to Pres., New York; Arthur J. McGinnis, Treasurer, New York; Ralph E. Westerman, Asst. Treas., Chicago.

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Editorial and Executive Offices: 30 Church street, New York 7, and 79 W. Monroe street, Chicago 3. Branch offices: Terminal Tower, Cleveland 13; 1081 National Press bldg., Washington 4, D.C.; Terminal Sales bldg., Portland 5, Ore.; 1127 Wilshire blvd., Los Angeles 17, Cal.; 1204 Russ bldg., San Francisco 4, Cal.; 2909 Maple avenue, Dallas 4, Tex.

Published monthly by Simmons-Boardman Publishing Corporation at Philadelphia, Pa. Subscriptions payable in advance. Postage free. United States, U. S. Possessions and Canada, 1 year $3. Other countries in Western Hemisphere: 1 year, $5. All other countries: 1 year, $7. 2-year subscriptions double the 1-year rate. Single copies 50 cents. Address Robert G. Lewis, Asst. to Pres., 30 Church street, New York 7.

The Railway Mechanical and Electrical Engineer is a member of the Associated Business Papers (A.B.P.) and the Audit Bureau of Circulation (A.B.C.) and is indexed by the Industrial Arts Index and also by the Engineering Index Service. Printed in U. S. A.

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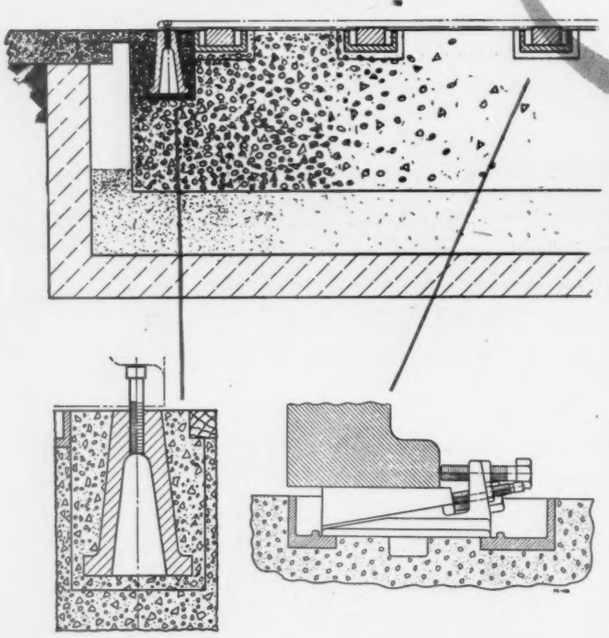
Microscope Aligning Instrument for checking accuracy of table way alignment.

HELPFUL HINTS FOR TOPNOTCH PERFORMANCE FROM YOUR LARGE CINCINNATI FILMATIC CENTERTYPE GRINDERS



Anchor bolt in foundation prepared especially for the machine.

Leveling blocks should be imbedded in the concrete foundation before the machine arrives.

You probably know that large centertype grinding machines are in critically short supply, so it will pay well to do whatever you can to keep yours running. Here are a few suggestions for the larger CINCINNATI FILMATIC Centertype Grinders—the 14" to 28" sizes.

FOUNDATION

Adequate foundations for long precision grinding machines are very necessary. Follow the recommendations outlined in foundation plans supplied with the machines.

LEVELING AND ALIGNMENT

Improperly leveled and aligned machines can be the source of many troubles. Wedge blocks are supplied to facilitate the leveling operation. Periodically recheck accuracy of level. When installing the machine, accurate alignment can be accomplished with the aid of a Microscope Aligning Instrument.

LUBRICATION

of your CINCINNATI FILMATIC Plain and Roll Grinding Machines is simple and easy; do not neglect it. As a reminder, make a lubrication chart and attach it to your machine.

OIL FILTERS

There are three oil filters—one for the FILMATIC spindle bearing lubricating system, and one each for the table way and wheelhead way oil. All are the replaceable type. Change them periodically; once a year should be sufficient.

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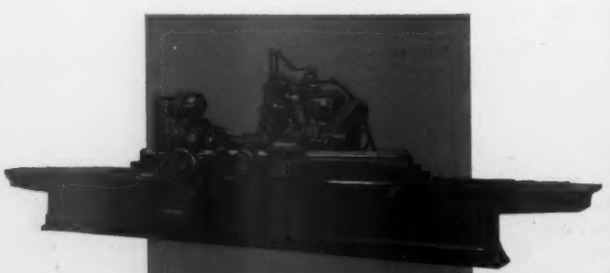

CINCINNATI FILMATIC 16" x 96" Roll Grinding Machine. Catalog No. G-600 contains complete specifications for the 16" Heavy Duty and 20" and 24" Plain and Roll Grinding Machines. Catalog No. G-587 covers the 20", 24" and 28" Heavy Duty Machines. Write for copies of these catalogs.

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CENTERTYPE GRINDING MACHINES • CENTERLESS GRINDING MACHINES
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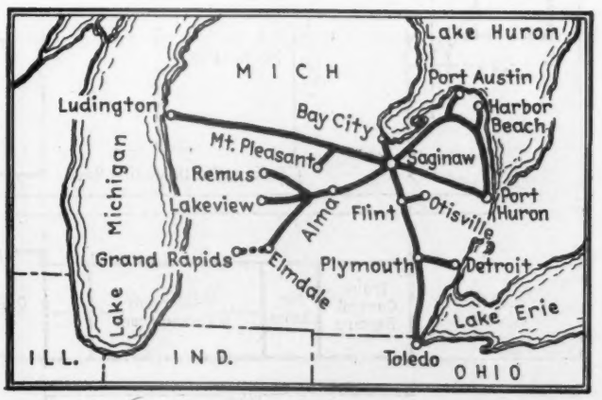
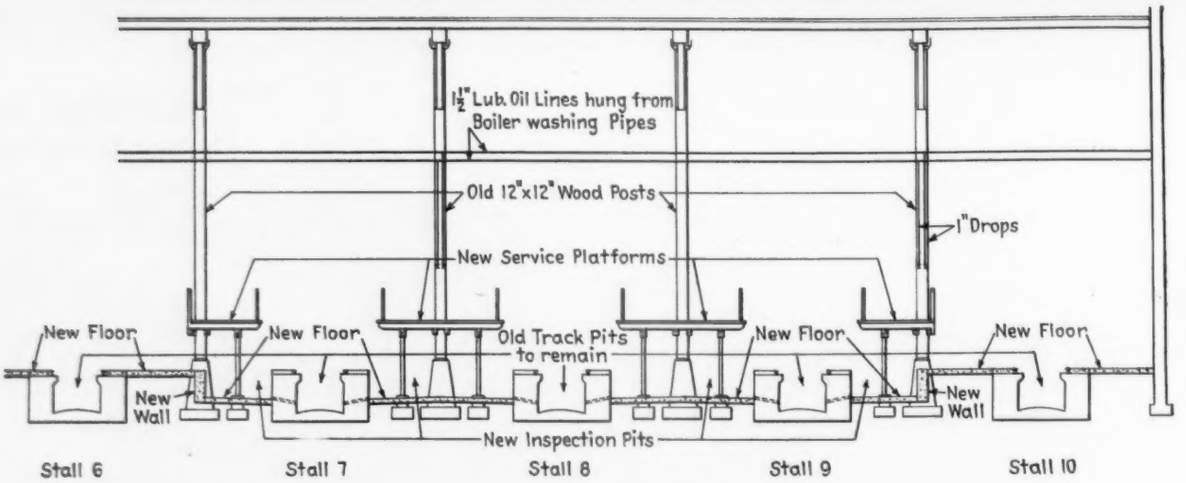
C. & O. Converts Terminal For Handling Diesel Power

Facilities at Saginaw, Mich., have ten working stalls and ten stalls for storing units during layovers

THE Pere Marquette district of the Chesapeake & Ohio has converted its former steam engine house at Saginaw, Mich., to a servicing and maintenance point for diesel power. The locomotives assigned to this terminal handle all traffic on the completely dieselized district shown on the map, with one exception. The trackage between Elmdale, Mich., and Grand Rapids is served primarily by locomotives assigned to the latter point, the Saginaw locomotives operating over this stretch only as part of the through run from Saginaw to Grand Rapids.

The Saginaw pool comprises 48 Electro-Motive units as follows: eight 1,000-hp. switchers, eleven 1,200-hp. switchers, seven BL-2 1,500-hp. road switchers, twenty GP-7 road switchers, and two 2,000-hp. passenger locomotives used mainly in freight services, and occasionally



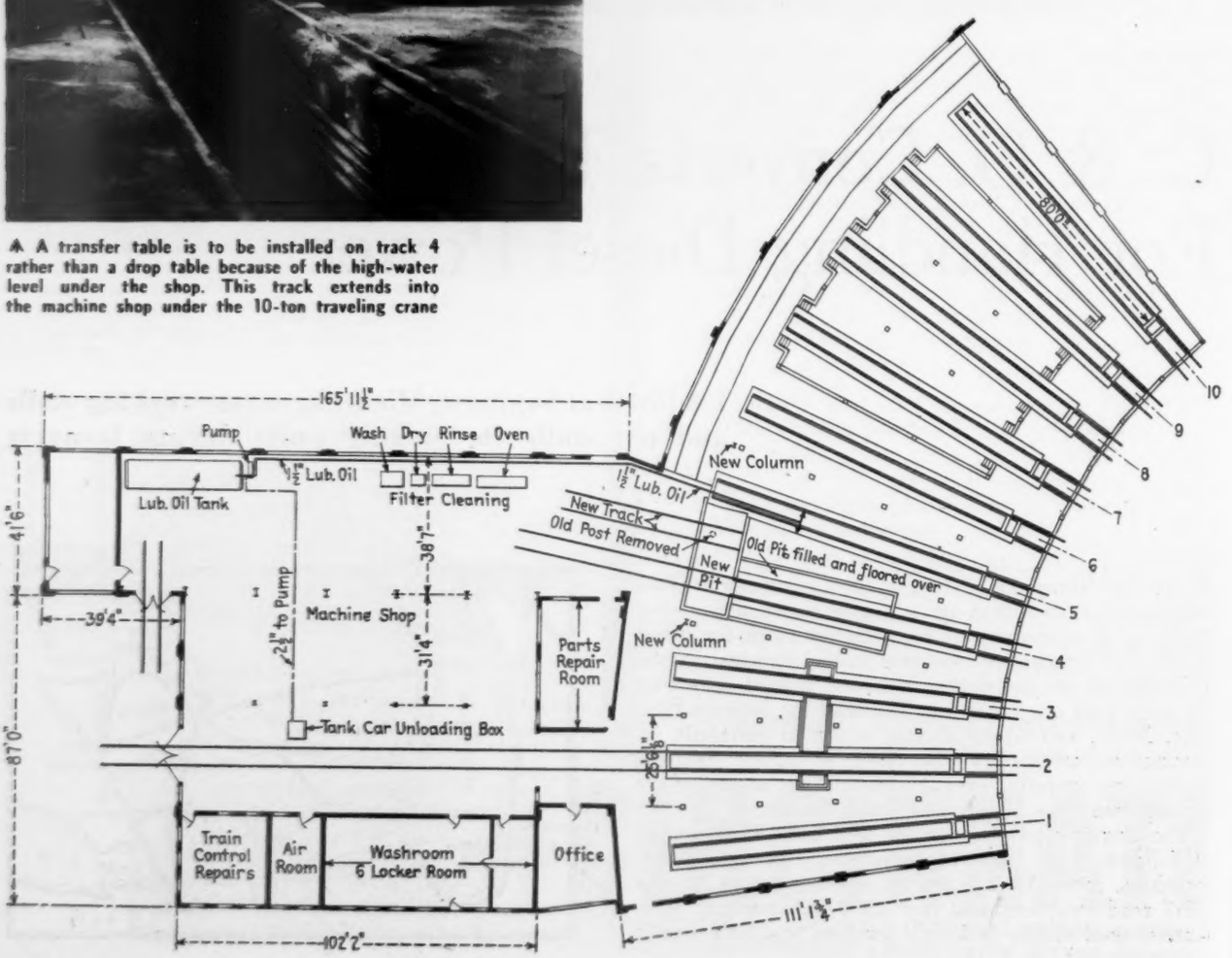


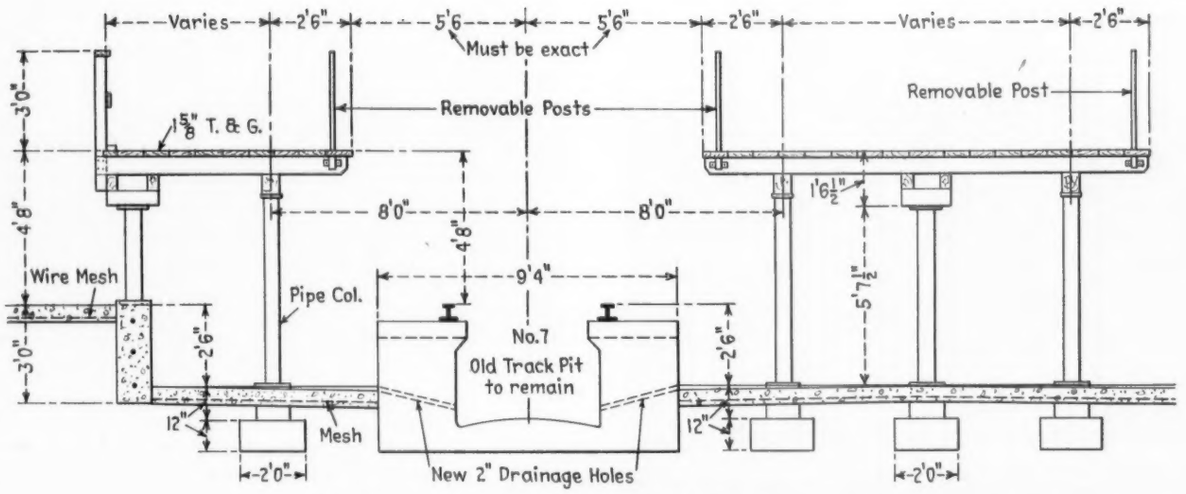
Stalls 7, 8 and 9 have depressed floors and cab-floor-level platforms. The remaining seven stalls are unchanged from steam days

A transfer table is to be installed on track 4 rather than a drop table because of the high-water level under the shop. This track extends into the machine shop under the 10-ton traveling crane

for special passenger trains. There is no regular passenger service on this district.

The above locomotives are both serviced and maintained at Saginaw, except for general overhaul which is performed at the Grand Rapids heavy repair shop. In addition to these 48, annual inspection and repairs to nine switchers stationed at Flint, Mich., are handled at Saginaw. Medium-heavy repairs to these nine up to and including liner pulling is also done at Saginaw. The same





Enlarged section through stall 7 and the adjoining platforms

procedure applies to a switcher stationed at Alma, which does local switching and covers the runs to Lakeview and Remus.

Dispatchments vary from 43 to 47 units each week day, and 25 to 27 on Saturdays and Sundays. All locomotives are brought into the house for servicing. Traction-motor suspension bearings are inspected prior to dispatching each time the locomotive enters the house.

Forty of the 48 locomotives maintained at this point operate in a general pool, and eight are assigned to specific runs. The two 2,000-hp. passenger units handle a time freight between Saginaw and Detroit, making one round trip per day. Three switchers, either 1,000 or 1,200 hp., operating as single-unit locomotives, are assigned to the branch line between Saginaw and Port Huron which runs via Palms. These three locomotives also handle the sub-branches leading from this line. A switcher is assigned to a local to Plymouth, and a second to a local to Mt. Pleasant. A 1,200-hp. switcher is assigned to the short, but heavy-tonnage, run to and from Bay City.

A board in the foreman's office, shown in an illustration, tells at a glance on what dates locomotives are due for monthly or more extended periodic inspections for the next 30 days. Each round tab on the board represents a locomotive unit. When a unit has received a monthly inspection, its tab is moved from the lower to the upper area on even numbered months of the year, and from the upper to the lower on odd months.

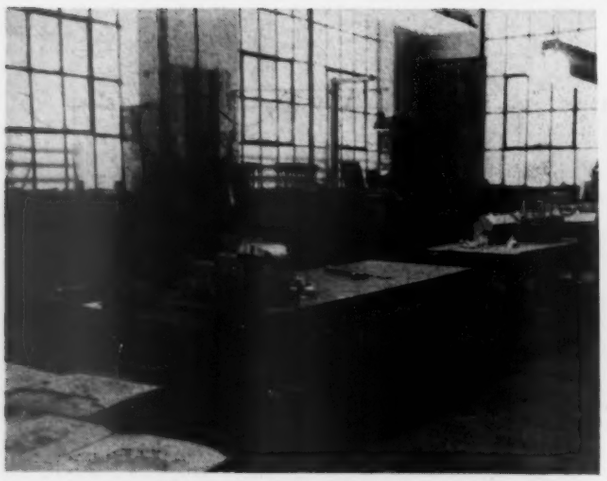
Unit 98, for example, received its monthly inspection October 7, and the tab was raised up to the November 7 position, indicating that it is due for its next inspection on that date. When it has received its November inspection, the tab will be moved to the lower column under the date of 7. By this time, however, the month indicator will have been changed from October to December, showing a due date of December 7 for the monthly inspection to Unit 98.

The board also shows any bunching up of work. Thus, five units are due October 12, while only one is due October 11. The foreman can thereby try to get some October 12 units on October 11 to even his out work load.

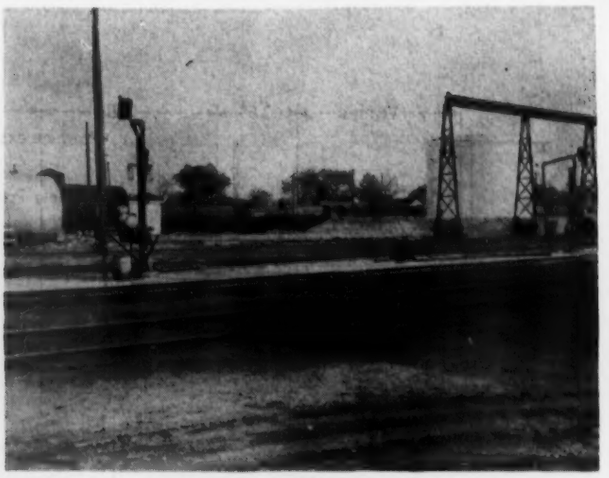
It can also be seen from the board what type of inspection is due. Tabs with just the unit number on indicate a monthly inspection; those with a red dot indicate an annual inspection. Seven other tabs, shown over dates of October 10-16, show days of the week (Sunday, Monday,

While the three stalls served by the floor-level platforms have depressed floors, the jacking pads were left in place

A new 40-ft. stub extending under the travelling crane was installed parallel to track 4 to serve as the outlet track for the transfer table

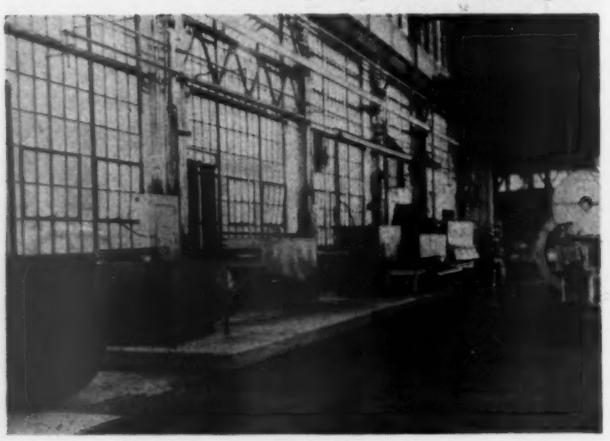


As most heavy repair work is done at Grand Rapids, this small room is adequate for parts reconditioning



Locomotives are fueled before entering the house on the two inside tracks bordering the concrete fuel ramp, where two units can be fueled simultaneously

Cleaning of filters and other parts is done in this area. The raised concrete platform is served by the jib crane in the background



etc.) as an additional guide in keeping the record straight.

The existing steam engine house had 30 stalls, a 100-ft. 6-in. turntable, a machine shop, and the necessary outside fuel, sand and water facilities, lead tracks, etc. The stalls were 80 ft. long and 4 ft. deep; all were heated by steam coils. A 1-ton monorail electric crane ran along the outside periphery of the house to serve all 30 stalls, and a branch extended into the machine shop. The machine shop was also served by a 10-ton travelling crane extending the entire length and having a span of 40 ft. Both cranes were retained.

The engine house, as converted to diesel work, is now divided into three sections. The first ten stalls, with individual modifications as necessary, are used for servicing and maintenance. The second ten stalls are used without change for storage during layover shifts and periods, while the last ten are no longer used.

Steam coils were retained in all stalls except No. 4 where the coils were cut off in installing a transfer table. Lubricating oil is piped directly under pressure to the first ten stalls from the 10,000-gal. tank. Two brands of detergent, heavy-duty oil are used—one exclusively in switchers, and the second for road power. No mixing of different brands is permitted.

The total of 20 stalls was retained for two principal reasons, the major one being for storage of power over weekends, when only half of the units are needed for operation. It is also helpful to have additional capacity in the working area at this point as the bulk of the work must be done on the first shift, on which 17 mechanics are employed, as contrasted with four on the second shift and seven on the third.

The degree of work done on the different parts of the locomotive varies with the part. In general, however, it can be said that most heavy mechanical repairs that become necessary between general overhauls are handled at this point, but that no major repairs are made to electrical equipment. Regularly scheduled heavy repairs to all equipment are done at Grand Rapids where switchers get a major overhaul every three years and road locomotives once each 18 months.

As to work handled on individual components, most engine work except crankshaft troubles and air box blower repairs are performed if the need arises between general overhauls. Auxiliary equipment receives minor servicing only; if serious difficulty exists, the part is replaced by one reconditioned at Grand Rapids.

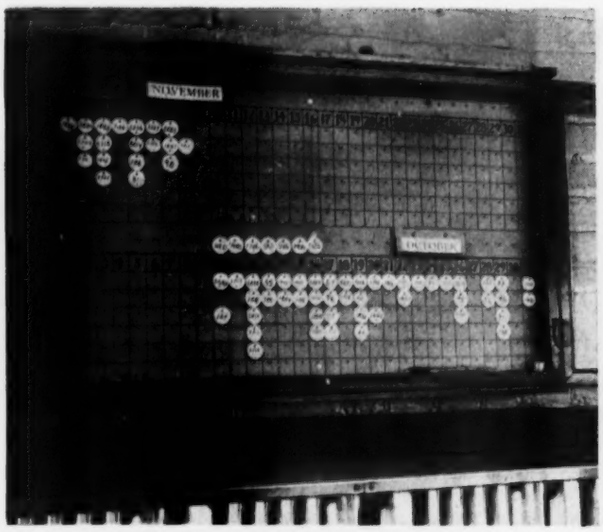
Truck work is handled completely, except that wheels are not turned at this point, but replaced by spare sets from the heavy repair shop at Grand Rapids. Day-to-day maintenance of the tread contour is done as needed with emery brake shoes. Body work is normally limited to minor straightening, but some heavy straightening is done if time permits and conditions dictate.

The majority of electrical work done is of the light type that can be done on the locomotive. Controls, and small motors and generators, are replaced with units reconditioned at Grand Rapids. Traction motors and main generators are maintained only; if necessary to change out, replacements are made with units reconditioned at Grand Rapids or by outside concerns. Batteries are watered only.

The heaviest work normally performed at Saginaw is that done in addition to I.C.C. work at annual inspections. This includes pulling and testing injectors, changing injector filters, air-testing the cylinders for blow-by, taking leads on the pistons for compression clearance, cleaning all electrical equipment, leads, risers, etc., and tightening all bolts and parts.

Layout of the Facilities

Of the ten stalls in the section devoted essentially to working on the locomotives rather than storing them, six



The board in the foreman's office for scheduling monthly, quarterly, semi-annual and annual inspections

Syntex bronze fuel filters are cleaned thoroughly and quickly with steam and blown out by air in this arrangement at stall 8

Lubricating oil is distributed to all stalls from this tank.

are unchanged from the steam locomotive days. Five of these are numbers 1, 3, 5, 6 and 10. The flooring is flush with the top of the rails, and the pits are 4 ft. deep. Daily servicing is done on these tracks without platforms or depressed floors. While this arrangement does not afford ideal working conditions at all times, the hindrance is not appreciable because of the 4-ft. pits.

Track 2 is the sixth track unchanged from the steam days, and, like the preceding five, has a 4-ft. pit 80 ft. long. It also extends into and through the machine shop. It is used primarily for making a quick inspection of suspension bearings, for which the extra length of the track is necessary in the case of multiple-unit locomotives.

Track 4 also enters the machine shop, extending far enough inside to be served by the 10-ton traveling crane, which is used for changing out traction motors, radiator fan arrangements and batteries, and for some engine work. The latter includes pulling heads, pistons and liners when more than one or two are to come out of an engine; where only a couple are to be removed a chain fall is ordinarily employed. This crane is used for this work because of the convenience of its location, and because no smaller crane suitable for this work is available.

A transfer table was installed rather than a drop pit because of the high water table under the house, which would create a serious problem in keeping the pit dry. The table to come will handle four-wheel trucks, and will therefore be suitable for working all locomotive trucks assigned to Saginaw except the two passenger-type units. It will transfer the truck to a stub track which is located halfway between tracks 4 and 5, and which extends into the machine shop area served by the crane.

Four 35-ton electric jacks raise the locomotive for truck changes. The transfer table is used for truck changes on the GP-7 and BL-2 road switchers only; on straight switchers the truck is rolled straight out on track 4.

Stalls 7, 8 and 9 have depressed floors 30 in. below the top of the rail, and locomotive-floor-level platforms 56 in. above the top of the rails. The jacking pads were left in along the outsides of the rails for the entire length of the pit. This arrangement does not provide quite as free a depressed-floor space, but this disadvantage is about compensated for by the extra platform for some truck and body work. It also permits the units to be lifted by electric jacks, if desired.

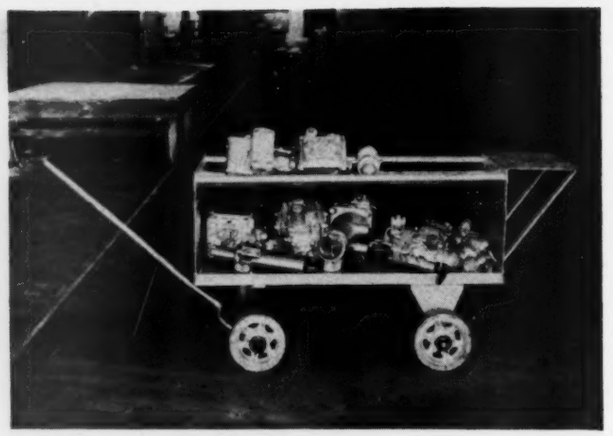
These stalls are used for monthly, quarterly, semi-annual and annual inspections, and for heavy repairs only. They were selected to be modified for this work largely by the process of elimination.

Stall 2 was eliminated as a starting point because it extended into the machine shop and was needed for suspension bearing inspection in between monthly inspections. This automatically eliminated Stall 1, as three stalls in succession were needed. Stall 4 was needed for truck work as it provided access to the crane in the machine shop, thus eliminating stall 3 also. Stalls 5 and 6 were on opposite sides of a fire wall, which eliminated 5; Stall 6 was too close to the wall. Thus Stalls 7-9 were the first three stalls in a row that could conveniently be used.

These three stalls also afford good natural lighting, not being blocked by the machine shop. They are also located reasonably close to the parts repair rooms, the machine shop, the cleaning area, and to the stalls used for daily servicing.

All four platforms are 44 ft. 7 in. long, and overhang the supports along the track edge by 30 in. The two center platforms are 10 ft. wide at the narrow end and 14 ft. 8 in. at the wide end. The end platforms have respective widths of 5 ft. 10 in. and 8 ft. 2 in. Both have guard rails of 2 by 4 lumber 3 ft. above the platforms, and floors of 1⅝-in. lumber. Supports are steel pipe columns 5⅜ in. in outside diameter.

The air brake room is compact and well equipped with the necessary tools and test equipment



Air-brake equipment is carried between the air room and the locomotive on this handy cart

Five such columns support the end platforms on the track side, and two supplement the three main building columns on the outside. A similar arrangement is used on the center double platforms, five columns supporting the two track edges and two supplementing the building columns along the center.

The lengthwise stringers along the track sides of the single platforms and the outsides of the double platforms are 6 by 8's. In all cases these run 30 inches from the edges. The inside stringers of the end platforms and the center stringers of the double platforms are two 4 by 6's mounted with the inside edges 10½ in. apart. Joists for all platforms are 2 by 6's on 24-in. centers. Steps and step supports are 2 by 10's. Four lights on the under side of each platform illuminate the running gear.

Syntex-bronze fuel oil filters are cleaned at the end of the double platform between Stalls 7 and 8. The filter is held in a section of tubing into which it fits snugly when in the open position as shown on the left in one of the illustrations. This piece of tubing extends down into a drain line with a slip joint on the lower end which allows it to be moved 6 or 7 inches up or down.

When the filter has been placed in the lower section of tubing, this section is raised to the position shown on the right, in which it fits snugly with the short top section of similar tubing by means of the collar on the lower section. The joint is secured with a slight turn of the handle mounted on the collar. The sections of tubing are then held together by a conventional twist joint consisting of a horizontal slot and a pin.

Cleaning now takes only a few seconds. Steam is admitted by opening the steam-line valve directly above the tubing. After cleaning, the filter is blown out by air admitted through valve in shop air line on the left.

Equipment Used for Diesel Work

A number of the existing machines in the machine shop are used for diesel work, including a power pipe threader, an 18-in. dry grinder, a bolt threader, a ½-in. and a 2-in. drill press. Among the heavier machinery that has been found helpful is a shears and punch press to cut sheets for repairing damaged locomotives, a 50-ton hydraulic press for straightening footboards, and for pressing off fan sheaves and Falk couplings, and a turret lathe for making miscellaneous fitting.

The principal work done in the parts repair room is along the lines of grinding valves, honing liners, repairing cylinder heads, testing lube oil and water, and some minor electrical repairs. This room also serves as a storage point for jobs performed at other locations in the shop. Included among the equipment in the room for both of these purposes is a valve grinder, a fixture for working heads and a diamond holder for facing the seat stone, a honing arrangement, a traction motor pinion puller, an induction heater for applying pinions, a flash-point tester, a radiator water tester, a storage cabinet for cylindrical filters, and storage space for such miscellaneous items as taps, dies, fuel filters, light bulbs, etc.

The air room has the usual array of equipment necessary for complete maintenance of air brake equipment. The principal work done in the train control room is on inductors, the remaining work on train control equipment being mainly minor adjustments and parts replacement. Major work on all parts, including motor-generator sets, is done at Grand Rapids.

General Operating Procedures

There are four principal tracks for moving locomotives in and out of the house. These line up with Stalls 14-17. Inbound locomotives enter on either of the two inside tracks, taking fuel on the way in, from the fueling station between these two inside tracks. The fueling station has two 300-g.p.m. pumps and can fuel two units simultaneously. Outbound locomotives for Grand Rapids and Ludington leave the house on a fifth lead track which lines up with retired Stall 30, and is roughly at right angles to the other four lead tracks. This track is used for this movement because the Saginaw yard is triangular, and if the other lead tracks were used the locomotive would have to go around two sides of the triangle to couple to its train. Locomotives are sanded from the old steam locomotive arrangement, using hoses off the side.

Lubricating oil is changed on the basis of test results, not mileage. Flash point tests are made weekly, and a full chemical test monthly. The test dates in each month for making the weekly flash point test are stenciled near the bayonet gage; the monthly chemical test is made at each monthly inspection. Crankcase fortification on makeup oil is not practiced.

Radiator water is treated in the engine, using regular city water as it comes from the tap. Saginaw has an unusually good water supply, which is used for batteries as well as radiators.

Economics of Freight-Car Roller Bearings*

By O. J. Horger†

Costs of Operation and Maintenance

This economic study was based on a one-year period of operation between July, 1950 and June, 1951 for which the Association of American Railroads gave a total of 34,719,916,640 car miles and 193,758 cars set off between division terminals. Detail studies now being conducted by an engineering-economic group in an educational institution provided some maintenance and operating statistics regarding the plain bearing on two Class I railroads operating in different regions of the United States. These data, along with other experiences, were resolved into costs per 1,000 car miles incorporating prices given in the A. A. R. interchange code of rules; such costs were then applied here to the yearly mileage of all Class I railroads. In doing this, it is recognized that the costs found on two railroads, operating only about 6 per cent of the loaded and empty freight car mileage for the country, or from other individual sources, may result in values higher or lower than the actual national average. The type of information needed in this analysis is not obtainable from the usual reports rendered by railroads so that it was necessary to use accessible data in this progress report until more is available.

data for roller bearings is given in Table 5. A summarized comparison statement of operating and maintenance costs for both types of bearings appears in Fig. 18. Detail calculations supporting the above tabular

Tables 3 and 4 and Fig. 17 show the costs of plain hearing hot boxes and service failures whereas similar data are presented in the appendix.

Railroad operating personnel, in criticizing the plain bearing, frequently cite the poor hot box performance record and the number of cars which must be set off between division terminals. As shown in Fig. 18, these costs are $1.61 per 1,000 car miles or only about 22 per cent of $7.34 found for overall costs of maintenance and operation of the plain bearing. Perhaps little objection has been raised to the remaining 78 per cent portion because of the accepted and routine nature of the maintenance work involved and, what is possibly more important, this expense does not present the spectacular interference with road operation. So that while service failures cause concern but only cost 22 per cent of the total expense, the preventive maintenance costs are actually still a more serious proportion or 78 per cent.

A saving of $6.49 per 1,000 car miles is obtained (Fig. 18) for roller bearings over plain bearings or $110.33 per car per year for an average annual mileage of 17,000 miles. About 36 per cent of this saving is in labor, 7 per cent in material, 16 per cent in locomotive hours and nearly 37 per cent in car days. Here a locomotive hour value of $35.00 and an average revenue earning capacity of a car of $10.00 is used.[2,3]

A separate statement of the total locomotive hours and

*Part II of a paper presented by the Railroad Division, American Society of Mechanical Engineers, at the annual meeting, Atlantic City, N. J., November 28, 1951. Part I appeared in the January issue.

†Chief Engineer, Railway Division, Timken Roller Bearing Company, Canton, Ohio.

TABLE 3—COSTS ON PLAIN BEARING HOT BOXES AND DEFECTIVE BEARINGS (SERVICE FAILURES) PER 1000 CAR MILES*

All Costs in Cents

	Cut journals							
	1st axle	2nd axle same car	Rebrass to repair track	R. & R. to repair track	Road rebrass	Rebrass	R. & R.	Total
HOT BOXES ON CARS SET OFF								
Number of cases	133,800	6,800	13,600	17,400	29,000	.....	.....	193,800
Cost of locomotive and car delays								
1. Locomotive delays due to set offs	13.488	.....	1.370	1.754	2.923	.....	.....	19.536
2. Car delays in train due to set offs	9.634	.....	0.979	1.253	2.088	.....	.....	13.954
3. Car delays lost on set offs and repair track	15.415	.....	1.567	2.005	1.671	.....	.....	20.657
4. Total delays (1 + 2 + 3)	38.537	.....	3.916	5.012	6.682	.....	.....	54.147
Labor Costs								
5. At point of set off	6.397	.....	0.650	0.832	1.387	.....	.....	9.266
6. At repair track	6.070	0.197	0.062	0.079	.....	.....	.....	6.408
7. Total labor (5 + 6)	12.467	0.197	0.712	0.911	1.387	.....	.....	15.674
8. Material	3.697	0.174	0.207	0.193	0.293	.....	.....	4.565
9. Total labor and material (7 + 8)	16.164	0.371	.919	1.104	1.680	.....	.....	20.239
10. Total costs (4 + 9)	54.701	0.371	4.835	6.116	8.362	.....	.....	74.386
HOT BOXES AND DEFECTIVE BEARINGS OTHER THAN SET OFFS FOUND IN SERVICE								
Number of cases	285,400	10,000	.....	.....	.....	166,900	48,300	500,600
11. Cost of car delays lost at repair track	24.660	.....	.....	.....	.....	14.421	4.173	43.254
12. Labor	12.947	0.290	.....	.....	.....	0.757	0.219	14.213
13. Material	6.181	0.196	.....	.....	.....	1.548	0.448	8.374
14. Total labor and material (12 + 13)	19.128	0.486	.....	.....	.....	2.305	0.667	22.587
15. Total costs (11 + 14)	43.788	0.486	.....	.....	.....	16.726	4.840	65.841
16. Accidents (Appendix Item 15)	.....	.....	.....	.....	.....	.....	.....	19.414
17. Fires (Appendix Item 16)	.....	.....	.....	.....	.....	.....	.....	1.590
18. Grand Total Cost per 1000 car miles for service failures only, excluding cost of scrapped axles and switching costs	.....	.....	.....	.....	.....	.....	.....	161.231

*Excluding Cost of Axles Scrapped because of Cracked or Worn Journals and Switching Costs
Above values obtained by dividing total cost in Table 5 by 34,719,916,640 miles.

TABLE 4—TOTAL COSTS ON PLAIN BEARING HOT BOXES AND DEFECTIVE BEARINGS—SERVICE FAILURES*

All costs in dollars unless otherwise shown

	Cut journal 1st axle	Cut journal 2nd axle same car	Rebrass to repair track	R. & R. to repair track	Road rebrass	Rebrass	R. & R.	Total
Hot boxes on cars set off:								
Number of cases in year	133,800	6,800	13,600	17,400	29,000	.....	.....	193,800
Locomotive and car delays—costs:								
1. Locomotive delays due to set offs	4,683,000	.....	476,000	609,000	1,015,000	.....	.....	6,783,000
2. Car delays in train due to set offs	3,345,000	.....	340,000	435,000	725,000	.....	.....	4,845,000
3. Car delays lost on set offs and repair track	5,352,000	.....	544,000	696,000	580,000	.....	.....	7,172,000
4. Total delays (1 + 2 + 3)	13,380,000	.....	1,360,000	1,740,000	2,320,000	.....	.....	18,800,000
Labor costs:								
5. At point of set off	2,221,080	.....	225,760	288,840	481,400	.....	.....	3,217,080
6. At repair track	2,107,350	68,544	21,420	27,405	.....	.....	.....	2,224,719
7. Total labor (5 + 6)	4,328,430	68,544	247,180	316,245	481,400	.....	.....	5,441,799
8. Material	1,283,543	60,472	71,985	67,129	101,732	.....	.....	1,584,861
9. Total labor and material (7 + 8)	5,611,973	129,016	319,165	383,374	583,132	.....	.....	7,026,660
10. Total costs (4 + 9)	18,991,973	129,016	1,679,165	2,123,374	2,903,132	.....	.....	25,826,660
11. Average cost per case	141.94	18.97	123.47	122.03	100.11	.....	.....	133.26
12. Cost per 1,000 car miles—cents	54.700	0.372	4.836	6.116	8.362	.....	.....	74.386
Hot boxes and defective bearings other than set offs:								
Number of cases	285,400	10,000	.....	.....	.....	166,900	48,300	500,600
13. Car delays lost at repair track—costs	8,562,000	.....	.....	.....	.....	5,007,000	1,449,000	15,018,000
14. Labor costs	4,495,050	100,800	.....	.....	.....	262,867	76.072	4,934,789
15. Material costs	2,146,208	68,200	.....	.....	.....	537,418	155,526	2,907,352
16. Total labor and material (14 + 15)	6,641,258	169,000	.....	.....	.....	800,285	231,598	7,842,141
17. Total costs (13 + 16)	15,203,258	169,000	.....	.....	.....	5,807,285	1,680,598	22,860,141
18. Average cost per case	53.27	16.90	.....	.....	.....	34.79	34.79	45.66
19. Cost per 1,000 car miles—cents	43.788	0.487	.....	.....	.....	16.726	4.840	65.841
20. Accidents (Appendix Item 15)	.....	.....	.....	.....	.....	.....	.....	6,740,525
21. Fires (Appendix Item 16)	.....	.....	.....	.....	.....	.....	.....	552,047
22. Grand total costs for service failures only excluding cost of scrapped axles and switching costs (10 + 17 + 20 + 21)								55,979,373
23. Grand average cost per 1,000 car miles—cents	.....	.....	.....	.....	.....	.....	.....	161.23
24. Grand average cost per case—dollars	.....	.....	.....	.....	.....	.....	.....	288.85

* Excluding cost of axles scrapped because of cracked or worn journals and switching costs.

Above costs obtained by multiplying number of cases by unit cost; unit costs given in appendix for locomotive delay (Items 5 x 9). Car delay in train (6c by 9), car delays on set offs and repair track (10 x 6a), labor and material (4).

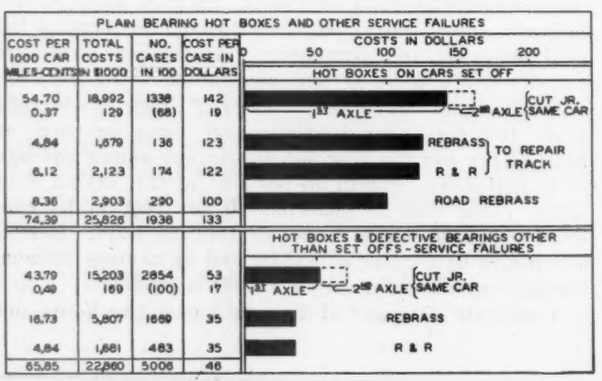
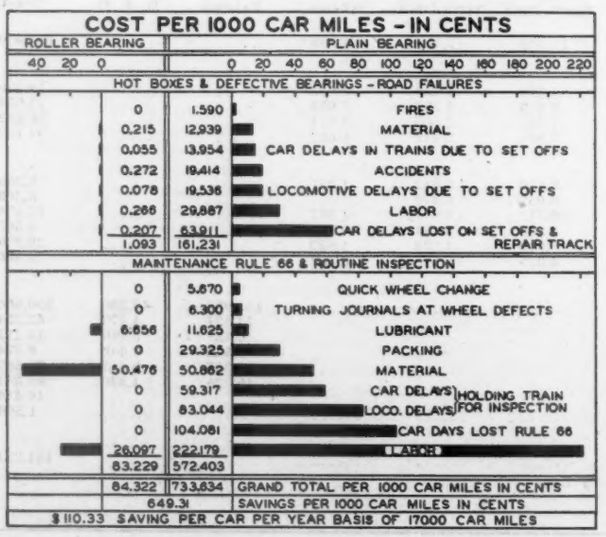


Fig. 17—Average cost of plain bearing hot boxes and other service failures

Fig. 18—Cost comparison and savings of roller bearings over plain bearings on all freight cars of Class I railroads


COST PER 1000 CAR MILES - IN CENTS
ROLLER BEARING
PLAIN BEARING
40 20 0
0 20 40 60 80 100 120 140 160 180 200 220
HOT BOXES & DEFECTIVE BEARINGS - ROAD FAILURES
0 1.590 FIRES
0.215 12.939 MATERIAL
0.055 13.954 CAR DELAYS IN TRAINS DUE TO SET OFFS
0.272 19.414 ACCIDENTS
0.078 19.536 LOCOMOTIVE DELAYS DUE TO SET OFFS
0.266 29.887 LABOR
0.207 63.911 CAR DELAYS LOST ON SET OFFS & REPAIR TRACK
1.093 161.231
MAINTENANCE RULE 66 & ROUTINE INSPECTION
0 5.870 QUICK WHEEL CHANGE
0 6.300 TURNING JOURNALS AT WHEEL DEFECTS
6.656 11.625 LUBRICANT
0 29.325 PACKING
50.476 50.862 MATERIAL
0 59.317 CAR DELAYS HOLDING TRAIN
0 83.044 LOCO. DELAYS FOR INSPECTION
0 104.081 CAR DAYS LOST RULE 66
26.097 222.179 LABOR
83.229 572.403
84.322 733.634 GRAND TOTAL PER 1000 CAR MILES IN CENTS
649.31 SAVINGS PER 1000 CAR MILES IN CENTS
$110.33 SAVING PER CAR PER YEAR BASIS OF 17000 CAR MILES

car days saved by the use of roller bearings is given in Figs. 19 and 20. These figures indicate that the same traffic could be handled with 117 less locomotives and 22,933 less freight cars representing an aggregate capitalization of $150,065,000. In his discussion of the railroad industry Budd[24] cited the hot box as being the most serious of purely mechanical problems of railway operation and termed the resulting loss of car days as "appalling" even though he admitted no statistics were available.

In the case of the roller bearing (Fig. 18) about 31 per cent of the operation and maintenance cost is labor and about 68 per cent material. Practically all of this cost is associated with bearing maintenance at the time the car is on the repair track for wheel work or air brake inspection. There should be no need for bearing maintenance at other times except for service failures recognized in Fig. 18. Mention should be made that the labor item of $2.22 per 1,000 car miles in Fig. 18 only includes the oilers who perform work on the plain bearing that would not be required on the roller bearing at time of train inspection. It is recognized here that mechanical inspection must be made of the train regardless of the type of journal bearing used. An inspector would continue to walk along the train and "feel" each journal box with either type of bearing.

The quick wheel change feature of the roller bearing truck is only shown evaluated on the basis of one-half of the cars having this feature[25] by truck side frame design in Fig. 4. The remaining one-half of the cars would have roller bearings applied in the integral box

[23] See Items 5 and 6 of appendix for these values. The $1.75 per diem for freight cars does not reflect the actual economic value, but if this value was substituted in this analysis for the $10.00 used, then the savings would be $4.50 per 1,000 car miles or $76.50 per year instead of those given in Fig. 18.

[24] Address by John M. Budd before the Coordinated Railway Association, Railway Purchases and Stores, October 1951, p. 86-89. An abstract of this address appears in the *Railway Mechanical and Electrical Engineer*, November, 1951, page 109.

[25] See item 18 in appendix; only one half of the cars were considered here to be so equipped because roughly one half the cars are over 20 years old and when replaced could be made to Fig. 4; otherwise, integral box side frames (Fig. 1) on cars under 20 years old would be used.

TABLE 5—NUMBER AND COSTS OF ROLLER BEARING HOT BOXES AND DEFECTIVE BEARINGS (SERVICE FAILURES)*

	Total costs in dollars				Costs per 1000 car miles in cents			
	Set offs				Set offs			
	Road change	To repair track	Other than set offs	Total	Road change	To repair track	Other than set offs	Total
Number of cases in year	260	510	1,545	2,315	260	510	1,545	2,315
Cost of locomotive and car delays:								
1. Locomotive delays due to set offs	9,100	17,850	.....	26,950	0.026	0.051	.....	0.077
2. Car delays in train due to set offs	6,500	12,750	.....	19,250	0.019	0.037	.....	0.056
3. Car delays lost or set off and repair truck	5,200	20,400	46,350	71,950	0.015	0.059	0.133	0.207
4. Total delays (1 + 2 + 3)	20,800	51,000	46,350	118,150	0.060	0.147	0.133	0.340
Labor costs:								
5. At point of set off	20,696	8,466	.....	29,162	0.060	0.024	.....	0.084
6. At repair track	4,914	19,404	38,934	63,252	0.014	0.056	0.112	0.182
7. Total labor (5 + 6)	25,610	27,870	38,934	92,414	0.074	0.080	0.112	0.266
Material costs:								
8. At point of set off	8,388	.....	.....	8,388	0.024	.....	.....	0.024
9. At repair track	.....	16,453	49,842	66,295	.....	0.047	0.144	0.191
10. Total material (8 + 9)	8,388	16,453	49,842	74,683	0.024	0.047	0.144	0.215
11. Total labor and material (7 + 10)	33,998	44,323	88,776	167,097	0.098	0.127	0.256	0.481
12. Total costs (4 + 11)	54,798	95,323	135,126	285,247	.....	.....	.....	.....
13. Average cost per case	210.76	186.91	87.46	123.22	0.158	0.274	0.389	0.821
14. Accidents (Appendix Item 15)	.....	.....	.....	94,367	.....	.....	.....	0.272
15. Grand total costs for service failures only (12 + 14)	.....	.....	.....	379,614	.....	.....	.....	.....
16. Grand average cost per case	.....	.....	.....	163.98	.....	.....	.....	1.093

* Excluding costs of defective axle and switching costs.

Above costs obtained as shown in footnotes under Tables 3 and 4.

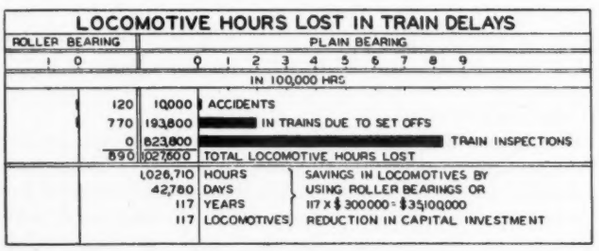
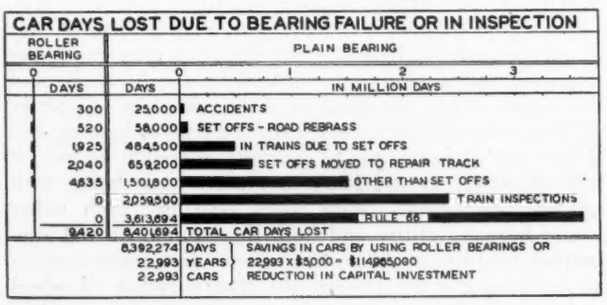

LOCOMOTIVE HOURS LOST IN TRAIN DELAYS
ROLLER BEARING
PLAIN BEARING
0
0 1 2 3 4 5 6 7 8 9
IN 100,000 HRS
120 10000 ACCIDENTS
770 193800 IN TRAINS DUE TO SET OFFS
0 823800 TRAIN INSPECTIONS
890 1027600 TOTAL LOCOMOTIVE HOURS LOST
1,026,710 HOURS
42,780 DAYS
117 YEARS
117 LOCOMOTIVES
SAVINGS IN LOCOMOTIVES BY USING ROLLER BEARINGS OR
117 x $ 300000 = $35100000
REDUCTION IN CAPITAL INVESTMENT

Fig. 19—Locomotive hours lost in train delays with both types of freight-car journal bearings

Fig. 20—Car days lost with both types of freight-car journal bearings


CAR DAYS LOST DUE TO BEARING FAILURE OR IN INSPECTION
ROLLER BEARING
PLAIN BEARING
0
0 1 2 3
IN MILLION DAYS
DAYS
DAYS
300 25,000 ACCIDENTS
520 58,000 SET OFFS - ROAD REBRASS
1,925 484,500 IN TRAINS DUE TO SET OFFS
2,040 659,200 SET OFFS MOVED TO REPAIR TRACK
4,635 1,501,800 OTHER THAN SET OFFS
0 2,059,500 TRAIN INSPECTIONS
0 3,613,694 RULE 88
9,420 8,401,694 TOTAL CAR DAYS LOST
8,392,274 DAYS
22,993 YEARS
22,993 CARS
SAVINGS IN CARS BY USING ROLLER BEARINGS OR
22,993 x $5,000 = $114965,000
REDUCTION IN CAPITAL INVESTMENT

type of side frame without the quick wheel change feature in Fig. 1.

Cost of Applying Roller Bearings

The cost of applying roller bearings on a new or converting an existing 50-ton car are given in Table 6 along with the credits for the omission of plain bearings. It is not known what charge the car builders would make for the roller bearing application so these costs are based on the work being done in a railroad shop. The usual railroad practice can be applied here of adding 60 per cent overhead on direct machining and assembly labor plus stores expense on material purchased. This 60 per cent includes 35 per cent for shop overhead, 10 per cent stores expense, and 15 per cent for pensions, vacations, etc. Furthermore, the price shown for the roller bearings and journal box parts of $550 is based on quantity production lots not realized at this time,

TABLE 6—COST OF ROLLER BEARINGS APPLIED TO 50-TON FREIGHT CAR BASIS OF RAIROAD DOING WORK IN ITS OWN SHOP

Item	Cost per car set—dollars: Covering existing cars using worn axle and side frames (Fig. 1)	Cost per car set—dollars: New cars using new axle forging and new side frames (Fig. 4)
Charges For Roller Bearing Application		
1. Roller bearing journal boxes and all mounting parts	$550.00 (Based on production lots not yet attained)	
2. Additional machining cost of roller bearing axle (Table 8)	21.44	12.16
3. Journal box assembly, pressing on axles and lubrication	22.40	22.40
4. Grease	3.60	3.60
5. Burning-out integral box side frame	21.02	.....
6. Total (1–5)	618.46	588.16
Credits For Omission Plain Bearings		
7. Rough turned axle (Table 7)	.....	10.16
8. Side frame (Fig. 4)	.....	72.20
9. Split bushings and wear plates on journal box hinge lug	.....	6.60
10. Eight journal bearings (AAR Rule 101, Item 162-D)	56.00	56.00
11. Eight wedges	16.00	16.00
12. Eight dust guards	1.36	1.36
13. Eight dust guard plugs	0.80	0.80
14. Eighty lb. packing	2.80	2.80
15. Eight packing retainers	4.16	4.16
16. Eight lids	17.20	17.20
17. Packing boxes	2.29	2.29
18. Total (7–17)	100.61	189.57
19. Stores expense	18.07	14.51
20. Application cost rollers bearings over plain bearings (6–18 +19)	535.92	413.10

Item 3: 8 man hrs. at $1.75 plus 60 percent overhead.
Item 4: 20 lb. at 18 cents per lb.
Item 5: 5½ man hrs. at $1.95 plus 60 percent overhead plus $4.42 for gas.
Item 19: 4 percent (550.00 − 100.61 + 2.29) = 18.07; 4 percent (550.00 − 189.57 + 2.29) = 14.51.

No shipping charges included in above table.

whereas the limited quantities currently purchased are considerably in excess of this figure.

It is apparent from Table 6 that the increased cost in applying roller bearings on a new car is $413.10 while the conversion of existing cars is $535.92 representing a difference of $122.80. About 76 per cent of this difference is allocated to two items of side frame cost and 16 per cent to two factors concerning the axle.

On the side frame, one item of $22.02 is for burning-out a portion of the journal box on the integral box side frame (Fig. 1) and the other being a credit of $72.20 for the jaw type frame (Fig. 4) as compared with the integral box (Fig. 1). The price schedule for conversion cars was based on using a worn plain bearing axle

TABLE 7 — AXLE WEIGHT AND COST DIFFERENCE OF ROUGH TURNED AXLES FOR BOTH TYPES OF BEARINGS

	Axle size, Lb. each		
	5 by 9 (In.)	5½ by 10 (In.)	6 by 11 (In.)
Plain bearing:			
Rough turned	698	833	1015
Finished	668	799	973
Roller bearing:			
Rough turned	664	791	958
Finished	638	761	924
Decreased weight roller bearing axle:			
Rough turned	34	42	57
Finished	30	38	49
Decreased cost of roller bearing axle over plain bearing axle, both rough turned at 6.05 cents per lb.	$2.06	$2.54	$3.45

which requires cutting off each end of the axle and recentering for a cost of $9.28 per car set. In the case of the new car, it was considered that a rough turned axle forging would be purchased which is expected will be $10.16 less per car set than for plain bearing axles. In view of these axle charges, the railroad would find it advantageous to save both items of $9.18 and $10.16 by purchasing new rough turned axle forgings for roller bearings up to the quantity of new plain bearing axles usually procured for maintenance and then continue the second hand plain bearing axle, removed from the conversion car, in service under other plain bearing cars. A similar procedure could be followed on the side frames to save both the $22.02 and $72.20 items by purchasing new frames for roller bearings (Fig. 4) up to the quantity of new plain bearing integral box frames usually procured for maintenance purposes.

Table 8 gives the weights of rough turned axles for both types of bearings as furnished by the axle manufacturer and the corresponding finish machined weight. It will be noted that the rough turned weight is less for the roller bearing which should reflect in the reduced cost values given where this value is $10.16 for a 50 ton car. The finish turning and burnishing of the axle is considered to be the same for both types of bearings. The extra operations involved on the roller bearing axle and not required for the plain bearing are drilling and tapping the ends of the axle and grinding the journal and dust guard diameters. The time and cost of these operations are shown in Table 8 incorporating 60 per cent railroad shop overhead. The additional cost for a 50 ton roller bearing axle would be $12.16 per car set when new axle forgings are used and $21.44 when worn plain bearing axles are remachined.

While Table 6 gives $413.10 as the additional cost for roller bearing application over a plain bearing on a 50 ton car this figure for a 40 ton car would be about $27.00 less and for a 70 ton car about $40.00 more.

Facilities for Roller Bearings

Roller bearings will require inspection and maintenance comparable to that given other types of high grade mechanical equipment already being serviced by the railroads. Roller bearing work will be handled at centralized shops as contrasted with the many outlying points maintaining plain bearings. The extensive supporting facilities ordinarily required for plain bearings will not be required and it will be possible to eliminate many of these facilities so as to reduce the annual maintenance and depreciation charges.

To insure maximum performance of the roller bearing inspection could be made in centralized wheel shops at the same time that the axle assembly is in the shop for wheel renewal. The journal box assembly is pressed off with the wheel so no special tools are necessary. Since the axle must be magnetically inspected, this operation leaves the axle stripped of all mounted parts. Facilities

TABLE 8 — ADDITIONAL FINISHING COST OF ROLLER BEARING AXLE OVER PLAIN BEARING†

			Cost of finishing roller bearing axle from (dollars)						
			Worn plain bearing axle			New axle forging*			
Operation	Man hrs. per axle	Hourly rate (dollars)	Labor	60 per cent overhead	Total	Total	60 per cent overhead	Total
Power saw cut-off both ends of axle	0.5	1.60	0.80	0.48	1.28	....	....	....
Recenter both ends	0.33	1.95	0.65	0.39	1.04	....	....	....
Drill and tap both ends of axle	0.307	1.95	0.60	0.36	0.96	0.60	0.36	0.96
Grind journals and dust guard	0.666	1.95	1.30	0.78	2.08	1.30	0.78	2.08
Finishing costs over plain bearing per axle	.....	....	....	....	5.36	....	....	3.04

† Based on method used by some railroad shops, i.e. direct labor plus 60 percent overhead.
* Forged to length, rough turned, and centered by axle manufacturer.

should be provided for cleaning, inspection bench, air jacks at each end of the axle in the production line for pressing bearings on the axles, and grease guns. Axle journals will require grinding equipment already available in some wheel shops or in most locomotive shops. Standard drilling and tapping heads can be mounted horizontally for providing means of placing holes in the ends of the axles. Grease guns will also be necessary at repair tracks for lubrication of the journal boxes while the car is being given periodic 36-month air brake inspection.

The elimination of cut journals would greatly reduce the handling, storage, repair track, and shop facilities now provided for plain bearings. There would be no need for maintenance of many existing facilities concerned with lubrication of the plain bearing such as reclamation plants for packing and shipping and distribution of this packing and bulk oil storage accommodations.

There are hundreds of mounted journal lathes at various outlying points on all Class I railroads serving only one purpose which is to turn cut journals on plain bearing axles. Many of these machines are worn out, obsolete and should be retired. The quality of work produced on such equipment often does not meet minimum requirements of accuracy required by the A. A. R. and the output is low resulting in high unit costs. If better performance is to be expected from the plain bearing and if this type of bearing is to continue in freight service, it will ultimately be necessary to replace such lathes with modern machinery. With roller bearings, such lathes would have no utility and both the equipment and supporting facilities could be eliminated. Even now there is an increasing trend toward the centralization of wheel and axle work as a means of improving quality, production, and making economic savings so that the use of roller bearings will expedite this movement.

Furthermore, there are hundreds of these lathes operating at outlying points which do not have equipment for making the required magnetic particle inspection of plain bearing journals. It will eventually be necessary to purchase such equipment. Still many other outlying shops may have the magnetic equipment, but do not perform the test or are using inefficient methods. With the use of roller bearings there would be no need for this magnetic equipment at outlying points, but only in centralized shops where efficient inspection methods could be better maintained.

The scope of this report does not permit a detail survey of the costs and credits involved in providing new facilities and abolishing existing ones. It is believed that roller bearings would greatly reduce present expenditures and ultimate investment in facilities.

TABLE 9—ESTIMATED INVESTMENT FOR ROLLER BEARINGS ON ALL FREIGHT CARS OF CLASS I RAILROADS

		Capacity car — tons			
		40	50	70	Total
Number of cars		200,000	1,407,000	400,000	2,007,000
Existing cars converted in railroad or private line shops	Number cars	100,000	680,500 (a)	200,000	980,500
	Cost per car, dollars	516	543	585	.....
	Total cost, dollars	51,600,000	369,511,500	117,000,000	538,111,500
New cars built in railroad and private line shops (b)	Number cars	30,000	211,000	60,000	301,000
	Cost per car, dollars	393	420	462	.....
	Total cost, dollars	11,790,000	88,620,000	27,720,000	128,130,000
New cars built at car builders' shops (c)	Number cars	70,000	492,500	140,000	702,500
	Cost per car, dollars	473	500	542	.....
	Total cost, dollars	33,110,000	246,250,000	75,880,000	355,240,000
Grand total cost, dollars		96,500,000	704,381,500	220,600,000	1,021,481,500
Reduced capitalization for: Cars (Fig. 20)				114,965,000	
Locomotives (Fig. 19)				35,100,000	
					150,065,000
Net increased capitalization					$871,416,500
Annual savings (d)			(6.4931 × 34,719,917) =	$225,439,891	
4 percent interest				34,856,660	
Net annual savings					$190,583,231
Return on investment after interest, percent					21.87
Number of years required to recover initial investment					4.57

(a) This figure includes deduction 23,000 cars not necessary per Fig. 20.
(b) This number of cars is about 30 per cent of new cars built with 70 per cent constructed by car builders which is in accordanace with current statistics.
(c) Figures used here are not quotations from builders and are only arbitrarily asumed values.
(d) Savings per 1,000 car miles (Fig. 18) × yearly mileage ÷ 1000 (Appendix, Item 1).

TABLE 10—MATERIAL USED TO REPAIR PLAIN BEARING SERVICE FAILURES

		Packing (a)	Bearing (b)	Dust guard (c)	Flame depressant	Total
Hot Boxes On Car Setoffs						
Cut journal, 1st axle	Number used	5	2½	2	1.5#	.....
	Unit cost	0.35	2.87	0.19	0.192	.....
	Total cost	1.75	7.175	0.38	0.288	9.593
2nd axle, same car	Number used	3	2½	2	1.5#	.....
	Unit cost	0.35	2.87	0.19	0.192	.....
	Total cost	1.05	7.175	0.38	0.288	8.893
Rebrass to repair track	Number used	2	1½	....	1.5#	.....
	Unit cost	0.35	2.87	....	0.192	.....
	Total cost	0.70	4.305	....	0.288	5.293
R. & R. to repair track	Number used	2	1	....	1.5#	.....
	Unit cost	0.35	2.87	....	0.192	.....
	Total cost	0.70	2.87	....	0.288	3.858
Road rebrass	Number used	1	1	....	1.5#	.....
	Unit cost	0.35	2.87	....	0.192	.....
	Total cost	0.35	2.87	....	0.288	3.508
Hot Boxes Other Than Setoffs						
Cut journal, 1st axle	Number used	4	2	2	....	.....
	Unit cost	0.35	2.87	0.19	....	.....
	Total cost	1.40	5.74	0.38	....	7.52
2nd axle, same car	Number used	2	2	2	....	.....
	Unit cost	0.35	2.87	0.19	....	.....
	Total cost	0.70	5.74	0.38	....	6.82
Rebrass	Number used	1	1	....	....	.....
	Unit cost	0.35	2.87	....	....	.....
	Total cost	0.35	2.87	....	....	3.22
R. & R.	Number used	1	1	....	....	.....
	Unit cost	0.35	2.87	....	....	.....
	Total cost	0.35	2.87	....	....	3.22

(a) Number journals packed at 10# packing per journal.
(b) Bearing cost—AAR Code Rule 101, Item 162D.
(c) Dust guard cost—AAR Code Rule 101, Item 163.

Investment

An estimate was made as to the capital investment required to apply roller bearings on all freight cars, Table 9. It was assumed that one-half of all the cars were roller bearing equipped when the cars were built and the other one-half of the total cars were converted from plain bearings to roller bearings. The unit costs shown in Table 9 were taken from Table 6 with an amount added to take care of estimated shipping charges.

After 4 per cent interest is charged on the net capital investment of $871,416,500 a 21.87 per cent return is obtained. At this rate, the initial investment would be recovered in 4.57 years.

Depreciation charges were acknowledged in the costs of maintenance by replacing 3 per cent of the bearings at time of wheel renewal as would be indicated at time of bearing inspection. An additional charge of $5.00 per journal box for replacement of other parts at this same time was also calculated as shown in the appendix, item 17g.

A dollar appraisal cannot readily be placed on all the merits of roller bearings and some of these advantages, not already so evaluated, are briefly enumerated as follows:

1. Little shipper dissatisfaction through car delays because of loaded cars set off for hot boxes or delay to other trains.
2. Permits faster train acceleration and higher maximum train speeds and unaffected by extreme cold or hot weather.
3. Large reduction in the number of train stops and delays on the road and in terminals for bearing conditions, which will allow better train schedule operation and train meets.
4. Reduced lading and car damage due to free slack action in the car couplings.
5. Obsolete outlying maintenance points and centralize wheel and axle shops.
6. Reduced switching costs of cars to the repair track for plain bearing journal work.
7. More uniform operation of roller bearing cars in classification and hump yards because the frictional characteristics are more uniform under temperature and loading variables.

APPENDIX

Basic Values Used in Cost Analysis

		Reference
1. Car Miles		
July, 1950 through June, 1951	34,719,916,640	A.A.R. Freight car hot-box record.
Year 1950		I.C.C. Statement No. M-211 (OS-A).
Loaded and empty	29,772,385,000	Item 4-09.
Caboose	518,719,000	Item 4-10.
	30,291,104,000	
2. Train Miles, 1950	514,880,141	Item 2-05.
3. Cars per Train (Average)	60	$\frac{30,291,104,000}{514,880,141} = 58.8$, say 60
4. Hot Boxes and Defective Bearings, Service Failures:		
(A) Plain bearing, Number of Cars:		
a. Total number	694,400	Average of one every 50,000 car miles[1].
b. Number set off	193,800	A.A.R. Freight-car hot-box record July, 1950 through June, 1951 = 193,758.
c. Other than set offs	500,600	a − b = 500,642[1].
d. Set offs rebrassed	29,000	15 per cent of b = 29,063[1].
e. Set offs to repair track	164,800	85 per cent of b = 164,694[1].
(B) Roller bearing:		
a. Total number	2,315	One per 15,000,000 car miles[2].
b. Number set offs	770	1/3 of a }
c. Other than set offs	1,545	2/3 of a } See Note 2
d. Set offs, road change	260	1/3 of b }
e. Set offs, to repair track	510	2/3 of b }
5. Train-Hour Value	$ 35.00	Signal Section, Advance Notice, A.A.R. Vol. 47, No. 1, 1949, page 51 gives composite average for 1948 of $33.16. Assumed increased costs for 1950 would give $35.00.
(Comprises "out-of-pocket" train hour costs + locomotive depreciation and payroll taxes but not interest on locomotive investment.)		
6. Car Value:	Revenue capacity per day, all cars	
a. Charge per day	$10.00	Average revenue on serviceable cars for 1950 was $11.59[3]. I.C.C. No. 29587, page 5, states the ratio of active cars to cars owned = 86.15 per cent for 10-year period 1936 to 1945. 86.15 per cent × 11.59 = 9.9848, say $10.00.
b. Charge per hour	0.0416	
c. Cost of one hour delay to train (60 cars)	25.00	
7. Number cars on Class I Railways	1,744,625	See Note 3.
8. Total Number Cars, Including Private Cars in Interchange	2,007,608	Item 7 + 262,983. See Note 3.
9. Average Train Delay Due to Set Offs, hr.	1	Average delay setting off and picking up car[1].
10. Average Car Days Lost Due to Bearing Road Failures:		
a. Car set offs, except road change	4	}
b. Car set offs, given road change	2	} See Note 1
c. Other than set offs	3	}

Calculations in Cost Analysis

11. Cost of Locomotive Delay Due to Set Offs:
    Plain bearing: 193800 hot boxes × 1 hour delay × $35.00 (4b, 9, 5)[4] = ... $ 6,783,000
    Roller bearing: 770 hot boxes × 1 hour delay × $35.00 (4b, 9, 5)[4] = ... $ 26,950
12. Cost of Car Delays in Trains Due to Set Offs:
    Plain bearing: 193,800 × $25.00 (6c, 4b) = $ 4,845,000
    Roller bearing: 770 × $25.00 (6c, 4b)[4] = $ 19,250
13. Cost of Car Days Lost on Set Offs and Repair Track: (See Table)

Cost of Car Days Lost on Set Offs and Repair Track

	No. days delay	No. Cases: Plain Bearing	No. Cases: Roller Bearing	Total days delay: Plain Bearing	Total days delay: Roller Bearing
Set offs given road change (10b)	2	29,000	260	58,000	520
Set offs, except road change (10a)	4	164,800	510	659,200	2,040
Other than set offs (10c)	3	500,600	1,545	1,501,800	4,635
Total days delay	..	.....	....	2,219,000	7,195
Total cost: Days delay × $10.00 (6a) =	..	.....	....	$22,190,000	$71,950

14. Cost of Labor and Material on Set Offs and Repair Track:
    Plain bearings $14,868,801
    Roller bearings ..... $ 167,513

Unit Costs[5]

LABOR AND MATERIAL TO REPAIR ROLLER BEARING SERVICE FAILURES:

(A) At point of set off:

	Road change	Set offs to repair track
50 miles truck @ 8 cents	$4.00	$4.00
24 man-hours @ $3.15	75.60	.....
4 man-hours @ $3.15	.....	12.60
Total	$79.60	$16.60

(B) At repair track:

Set offs: Road change, 6 man-hours @ $3.15 =	$18.90
Set offs to repair track or other than set offs, $15.75 (Item 14C (1) plus 3 man-hours @ $3.15 =	$25.90
Material for all service failures:	
Bearing	$31.36
Grease	.90
	$32.26

LABOR TO REPAIR PLAIN BEARING SERVICE FAILURES—A.A.R. CODE RULE 107[b]:

(C) Cut journals, replacing axle at repair track:
(1) First axle: Item 165 − note under

[1] Based on detail study made on two Class I railroads.
[2] Based on experience with Timken bearings on freight and passenger cars and locomotives.
[3] Statistics Car Building & Car Repairing; American Railway Car Institute, 1950.
[4] Bracketed numbers refer to items in appendix.
[5] For summary and total costs see Tables 3, 4 and 5.
[6] For detail costs on plain bearing material see Table 10.

Calculations in Cost Analysis *(Continued)*

item 168 + item 83 × item 92 (5.2 hours − 1.2 hours + 1.0 hour) × $3.15 = ... $15.75

(2) Second Axle: Assuming it occurs 50 per cent time in same truck as first cut journal and 50 per cent time on other truck:

$$\frac{\$1.75 + (\text{items } 167 - 168) \times \text{Item } 92}{2}$$

$$\frac{15.75 + (2.6 \text{ hours} - 1.2 \text{ hours}) \times \$3.15}{2}$$

= $10.08

(D) Rebrass or R. & R. at repair track − item 89 × item 92 ½ hour × $3.15 = $1.575

(E) Repairs at point of set off (average case):
50 miles truck @ 8 cents = ... $ 4.00
4 man-hours labor @ $3.15 = ... 12.60

Total $16.60

15. Cost of Accidents Due to Broken Journals (Fig. 10):
Total number 833; average delay, 12 hours; total delay, 10,000 hours.
(A) Damage to equipment, $2,439,267; to tracks, $1,506,676; clearing wrecks, $645,872. Total ..... $ 4,591,815
(B) Locomotive delay, 10,000 × $35.00 (5) $ 350,000
(C) Car delay in train 10,000 × $25.00 (6c) $ 250,000
(D) Damage to lading, detouring trains, delay to other trains assume 15 per cent of (A) or ..... $ 688,722
Total cost, 1950, $5,880,587 or 19.414 cents per 1,000 car miles.
Total cost calculated for 1950–1951 mileage (1) ..... $ 6,740,525
One roller bearing accident per 3 billion car miles:

$$\frac{34{,}719{,}916{,}640}{3{,}000{,}000{,}000} = 11.57 \text{ or } \frac{11.57}{833} \text{ of the}$$

cost of a plain bearing accident, total cost $ 94,367

16. Cost of Fires Due to Overheated Journals (Fig. 16):
330 fires, $483,132, or 1.59 cents per 1,000 car miles for 1950. Cost calculated for 1950–1951 mileage (1) ..... $ 552,047

17. Cost of Maintenance, Rule 66 and Routine Inspection:
PLAIN BEARING
(A) Oil, 3 pints per 1,000 car miles: 34,719,917 × ⅜ = 13,019,969 gals. Total cost at 31 cents per gal 4,036,190
(B) Packing, 9 lb. per 1,000 car miles: 34,719,917 × 9 lb. × 3.5 cents per lb. is $10,936,774 which includes $755,020 cost of road failure (14). Total cost rule 66 and routine inspection $10,181,754
(C) Labor: 4,145,555 days × 8 hrs. × 2.326[7] $77,140,487
(D) Car days lost due to repack rule 66: 2,007,608 (8) × 1½ (average repack per year) = 3,011,412 cars repacked. 3,011,412 × 0.6 (car sent to repair track for repack) = 1,806,847 cars. 1,806,847 × 2 days delay = 3,613,694 days lost × $10.00 (6a) $36,136,940
(E) Other material:
Brasses $12,953,916
Dust guards ..... $ 398,519
Flame depressant ..... $ 5,210
Box lids ..... $ 2,090,486
Wedges ..... $ 89,057
Axles ..... $ 2,122,428

ROLLER BEARING
(F) Grease:
1. At inspection:
Inspection once in 3 years. ⅓ of 2,007,608 cars (8) × 8 boxes per car = 5,353,624 boxes. 1 lb. × 5,353,624 × 18 cents = ... $ 963,652
2. At wheel renewal:

$$\frac{34{,}719{,}916{,}640\ (1)}{150{,}000 \text{ wheel life}} \times 4 \text{ pairs per}$$

car = 925,864 pairs renewed. 925,864 × 2 = 1,851,728 boxes. 2½ lb. × 1,851,728 × 18 cents = ... $ 833,278
3. At wheel turning:

$$\frac{34{,}719{,}916{,}640}{25{,}000} = 1{,}388{,}800 \text{ pairs}$$

requiring turning. 1,388,800 − 925,864 pairs renewed = 462,936 pairs turned. 2 lb. × 462,936 × 18 cents = $166,657. Total costs (1+2+3 = ... $ 1,963,587

(G) Material:
1. Bearings:
2,007,608 (8) × 16 per car = 32,121,728. Assume 3 per cent replacement, 963,652, less road failures, 4,630 = 959,022. 959,022 bearings × $15.68 per bearing = $15,037,465
2. Miscellaneous:
963,652 ÷ 2 = 481,826 journal sets. 481,826 × $5.00 = ... $ 2,409,130
3. Axles:
⅜ of 2,315 service failures × $51.50 = ... $ 78,847

(H) Labor:
1. At inspection (Rule 66):
12 minutes or ⅕ hr. 669,203 cars × ⅕ × $2.326[7] = $311,313
2. At wheel renewal:
925,864 pairs × 3 hrs. × $3.15 = $8,749,415.
Total 1 + 2 = ... $ 9,060,728

18. Other Savings:
(A) Roller bearings will eliminate turning journals on wheel defects 1,388,800 defective wheels × ½ hr. per pair × $3.15 = ... $ 2,187,360
(B) Quick wheel change saving, 0.9 hr. per pair, Rule 107, item 165-166. Assume ½ wheels are quick change. 1,388,800 × ½ × 0.9 × $3.15 = ... $ 1,968,624
(C) Car days lost on inspection enroute:
Inspection time per car. 320 seconds plain bearing less 30 seconds roller bearings is 290 seconds saving per car.

$$\frac{290 \times 60 \text{ cars } (3)}{3{,}600 \text{ seconds}} = 4{,}833 \text{ hrs.} + 4 \text{ men}$$

= 1.2 hrs. saving per train

$$\frac{514{,}800{,}141\ (2)}{2} = 257{,}440{,}070 \text{ train}$$

miles inspections made assuming ½ of trains need no intermediate inspection. 257,440,070 ÷ 375 miles between inspection = 686,500 inspections made.

$$\frac{686{,}500 \times 60 \text{ cars } (3) \times 1.2 \text{ train hour saved}}{24 \text{ hours}} = 2{,}059{,}500 \text{ days}$$

saved. 2,059,500 × $10.00 = ... $20,595,000
(D) Locomotive delays due to inspection, 686,500 inspection × 1.2 hrs. × $35.00 (5) = ... $28,833,000

[7] Freight car lub. rate = $\frac{\text{Pass. Lub. rate} \times \text{Frt. car repair rate}}{\text{Pass. Car Repair Rate}}$ = $\frac{\text{PC rule 21 item 19} \times \text{rule 107 item 92}}{\text{PC rule 21 item 20}}$

Waste Packed Journals*

Lack of confidence in low-viscosity high-film-strength oils is responsible for the opinion waste packing is becoming obsolete

By L. D. Grisbaum†

In August, 1950, the Association of American Railroads issued specifications for both new and renovated journal box lubricating materials to become effective as of January 1, 1951. The urgency for the new specifications and the short time available for their preparation precluded the possibility of utilizing fully the data resulting from the comprehensive studies of car oil and journal box waste carried out by the Association at the Indianapolis Lubrication Laboratory which resulted in something far short of an optimum specification. In spite of this, it has been most valuable from a psychological standpoint and has resulted generally in a better and more uniform material from a functional standpoint. Because they are intended as interim specifications and will be in service for a short time only, it is difficult to evaluate the lubrication benefits, if any, that can be credited directly to them. It is certain, however, that reducing the current specifications to practice was a step in the right direction; as from this beginning is already emerging specifications for car oils whose behavior in service, rather than personal opinions, is dictating the physical dimensions of the oils.

During the past five years there has been a noticeable decrease in the car miles per hot journal on freight train cars and the tendency of the curve continues sharply downward. Every mechanical railroad man may well ask and give some serious thought to two questions: Is his pool of journal box packing of sufficient quality efficiently and economically to lubricate his journals; and, if not, what are the potential possibilities of journal box packing as an economic and efficient lubricant? The answer to the first question is obviously a matter of studying and comparing his records of operation and his direct and indirect cost of lubrication. The answer to the second question is less obvious and is the basis of this paper.

There is much experimental evidence both from the laboratory and the railroad definitely to indicate that from a technological standpoint the lubrication efficiency and economy of journal box packing can be greatly improved. Whether or not the potential possibilities are ever obtained depends to a large extent on the willingness of the railroads to rationalize their respective views on the psychological phase of the problem. There are no fundamental differences between the railroads in the lubrication of conventional car journal bearings; the problems are identical and the theoretical approach should not differ. Why then are the answers to the problem and the practices of car journal lubrication so varied that they can only be given in paradoxical and qualified terms? The operating results are no better or worse than the dominant opinion responsible for the lubrication practice on any railroad; and, because of interchange, the ultimate results of this opinion are felt through the country.

From the earliest days the waste pack lubricator has been the standard method of journal bearing lubrication.

It was a relatively simple operation to change a liquid oil to a solid state by saturating it into a fibrous material that would not only feed oil to the bearing in excess of that necessary to support film lubrication, but would retain the oil in the box and in a position to lubricatae the journal. When we think of solid or semi-solid lubricants, we presuppose oils that have been thickened with metallic soaps or fatty acids. The mechanics of a waste pack lubricator is similar to that of grease lubrication. As the mobility and activity of the oils in either case are decreased, more work is required to get the lubricants to the journal and more heat is generated in film shear. On this broad premise the practice of using heavy oil for summer operation and lighter oil for winter operation is not only bad lubrication engineering, but bad functionally because car oils are not changed in journal boxes on a seasonal basis. The lack of an all-season oil or perhaps, more recently, the lack of confidence in the relatively low-viscosity, high-film-strength oils available and necessary to satisfy the many lubrication and functional requirements of an all-season car oil is responsible in a large measure for the growing opinion that the waste pack lubricator is hovering in the shadows of obsolescence. Through the years there have been many attempts made to find ways of replacing the packing in journal boxes, but little serious effort fully to understand the mechanics of the waste pack lubricators and its potentials. We have operated with fluctuating fortunes but never with a sustained satisfactory year-round performance. Perhaps lack of universal progress in elevating the efficiency of the waste lubricator was at least partly due to the fact that bearing failures during the months of favorable atmospheric conditions were within a reasonable expectancy, while the peaks in the failure curve were accepted as the natural result of inherent conditions due to extremes in atmospheric temperature and climatic conditions. All packing was grist to the mill; and with the possible exception of the special materials reserved for on-line equipment, little attention was paid to quality and less known about its lubricating value. In spite of which, when considering the large number of journal boxes in daily operation, actual failures (if we charge all hot boxes to lubrication) are relatively few.

When heat is generated in a journal box at a faster rate than it can be dissipated, a bearing failure occurs. The sources of heat are the bearing and packing friction both of which are subject to a measure of control. The starting point to improvement in packing lubrication

*Abstract of a paper presented by the Railroad Division of the American Society of Mechanical Engineers at its annual meeting, Atlantic City, N. J., November 28, 1951.

† Chief Engineer, Railway Service & Supply Company, Indianapolis, Ind.

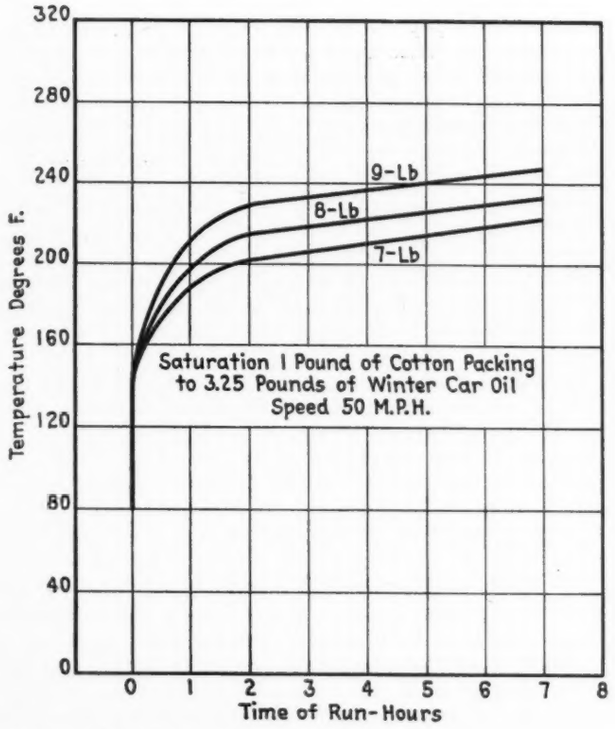


Fig. 1—Influence of various amounts of packing upon operating temperature

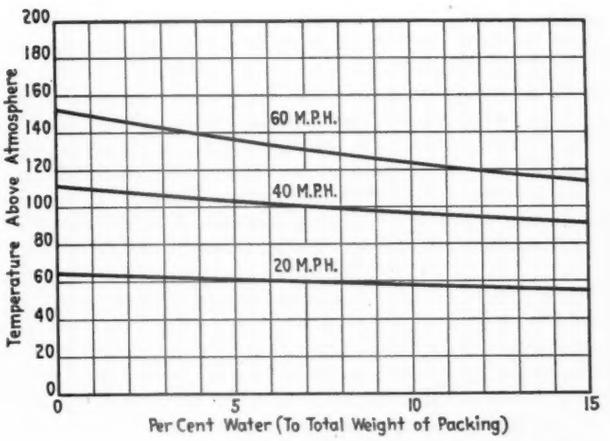


Fig. 2—Effect of increasing water content of journal-box packing upon operating temperatures, 20,000-lb. journal load

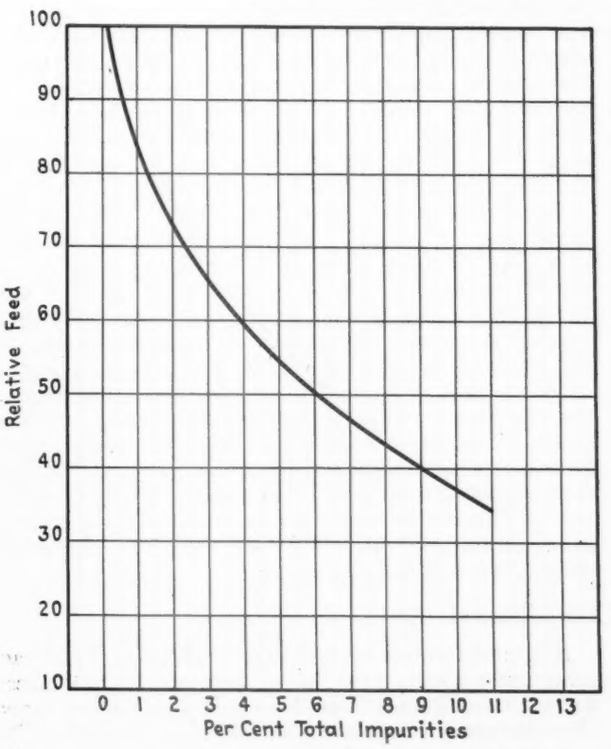


Fig. 3—Decrease in oil fed to bearing as dirt in packing increases

lies in reducing to a minimum the temperature generated under maximum operating conditions of load, speed, and under extremes of atmospheric temperature to a point where the thermal gradient between the oil film and the box roof will dissipate the heat as rapidly as it is generated. The lower this stabilized temperature can be maintained, the higher the lubricating factor of safety.

Under laboratory procedure and with current specification materials, fully half the heat generated in a journal box is caused by the friction of the packing against the journal which, while being difficult to control, can be minimized by mechanical improvements in the correlated parts of the journal box and more careful attention to packing and servicing the boxes. The principal items in this category are—

(a) Excess packing in the box (Fig. 1); (b) Increase in packing resilience due to evaporation of moisture during periods of high atmospheric temperature (Fig. 2); (c) Increase in adhesiveness during periods of low atmospheric temperature, and (d) The reduction of oil feed and increased friction with the build up in extraneous materials in the packing (Fig 3).

The two principal controllable factors that influence packing friction are the viscosity of the oil and the type and kind of threads in the packing waste. The low viscous oils not only produce less packing friction, but carry less extraneous matter, including lint, to the bearing; reduces or prevents rolling of the packing; and feeds more oil to the journal.

There is an optimum relationship between the gauge of the threads in the packing waste and the ratio of oil saturation which is directly influenced by the viscosity of the oil. It is possible to control rolling of packing in the journal box due to the friction of the packing on the journal by reducing the ratio of oil to waste as the gauge of the thread decreases. In a wellfitted journal box containing packing saturated with the usual ratio of 3½ parts of oil to 1 part of waste, the oil lost from the journal box in the first 50 miles of travel will vary between 15 and 20 per cent after which little, if any, further loss occurs. It so happens that the resultant or stabilized saturation of from 2.75 or 3.00 to 1 appears to coincide with the best saturation ratio to prevent packing displacement in the journal box with oils within the viscosity range of specification EM 906-50 (50 to 55 sec. at 201 deg. F.) when used with the extremely fine threads currently being furnished as packing waste. As the viscosity of the oil is lowered from a 50-second range to 40 seconds the saturation of the packing can again be increased without undue packing displacement.

It is also possible in the laboratory under both extremes of ambient temperature to control packing displacement in the box by elevating the temperature of the packing by extending the preliminary or orientation run before testing, thereby lowering the viscosity of the

oil to a point where the forces of adhesion of the oil is less than the force of gravity, in which case there is not sufficient oil on the surface of the packing in juxtaposition to the journal to cause the packing to roll. Since oil in excess of fiber saturation is held in the packing by the viscosity of the oil and surface tension, temperature in excess of ambient is necessary to reduce saturation of the packing at the journal surface to a point where the journal is barely wetted with oil and its adhesiveness is, therefore, reduced to the point of impotency. If all boxes requiring servicing could be tooled while still at running heat, this natural phenomena would work to advantage. However, the necessity to tool packing when the journal box assembly is at or about ambient temperature, squeezes the oil to the surface of the packing where it remains in excess amounts; and, when the journal is put in motion, any oil pooled on the top of the packing will rise on the journal carrying the loose extraneous materials to the bearing. The heavy layer of oil between the packing and journal being under pressure is subject to shear and the higher its resistance to the movement of the journal, the greater the degree of packing displacement. Since boxes are packed and serviced under many temperature conditions which cannot be controlled, improvement in packing displacement must again depend on the lubricant. It is fortunate that the rate of migration of the oil through the waste can be controlled by the simple expedient of reducing its viscosity.

In addition to the waste pack being a means of self lubricating the journal, it possesses all the characteristics of a good oil filter. Like all filters of this type, as the extraneous matter builds up in the fiber of the waste and the filter becomes more efficient, the waste pack, as a lubricator, becomes less efficient with reduced oil feed to the journal. The lighter the oil the less filterable material carried with it on its way to the journal, and the greater the rate of oil fed to the bearing. This again indicates that low viscosity car oil is beneficial in waste packing. Because the waste pack is a filter, any practice or device that interferes with tooling the packing which is necessary to disperse the filter cake accumulated at the surface of the packing will eventually result in starved lubrication and an increase in failures.

Car Journal Oil

It is most fortunate that the axle load limits of railroad train cars are well within the strength capacity of the best bearing metal known. Lead base babbitt is not too fussy about the kind or degree of hardness of the journal, or its contour. It is likewise tolerant of insufficient and dirty oil. The relatively thick babbitt lining together with the soft bronze back makes a readily deforming unit that has the faculty of adapting itself to considerable misalignment and dimensional tolerance. The natural unctuousness of babbitt helps to keep temperatures low; and, if lubricated with an oil of proper viscosity and a high degree of oiliness, will operate with a low co-efficient of static and dynamic friction and pay handsome dividends in greatly improved performance.

In car journal lubrication, like any high grade lubricating job, the two more important characteristics of the lubricant are:

(1) The proper viscosity of the oil at the operating temperatures and pressures where lubrication is in the region of fluid film: (2) Oiliness where lubrication is in the boundary film region, and (3) Mentioned last for emphasis, because it is most important that car oils have viscosity characteristics that will assure optimum functional behavior with waste, as set forth in the preceding section of the papers. Any improvement, therefore, in the economy and efficiency of the waste pack lubricator must be based on the premise that the oil must satisfy the lubricating requirements of the bearing with a generous factor of lubrication safety (anything in excess of this is a waste of energy with more heat to dissipate), as well as the complex functional requirements that waste imposes on journal lubrication. After establishing the entity of this new kind of car oil by fixing its physical measurements from performance behavior, it not only must be readily available as new car oil, but the present pool of oil after being renovated must be converted by blending and medication to identical specifications and performance.

Under A.A.R. Specification E. M. 906-39 for new car oil, in force until January 1, 1951, it was possible to select an oil having a viscosity from 45 to 118 Saybolt Universal seconds (S.U.S.) at 210 deg. F. depending on the viscosity index of the oil, the only limitation being a maximum viscosity at 100 deg. F. of 725 seconds. The current specifications for both new and renovated oil materially narrows the viscosity spread to 50-55 seconds at 210 deg. F. and sets the limit at 100 deg. F. by providing for a minimum viscosity index of 80. This is a considerable improvement and a decided step in the right direction.

While good viscosity temperature characteristics are an important property of a quality lubricant and a high viscosity index is a desirable characteristic in a car oil, of far greater importance is its ability to maintain full fluid film lubrication and to support heavy loads at relatively high temperatures under boundary lubrication with a considerable lower viscosity oil than is provided for in the current specifications. While the opinion still prevails in many places that even heavier oils are necessary to avoid film rupture under heavy loads and high ambient temperature. Its continued use imposes the penalty of higher total friction, and operating temperatures; and, therefore, more border line cases of insipient fevered bearings. By the use of oiliness or film forming improvers, it is possible to combine low internal friction, low packing journal friction, and low viscosity with high resistance to film failure and thereby more closely approach optimum lubrication over the entire range of car journal operation with one oil for all-year use.

In the preparation of the current A.A.R. car oil specifications it was attempted to make an all-season oil from one of relatively high viscosity by lowering the pour point by artificial means. Since pour point is a physical dimension that has no influence on the lubricating value of a car oil, it apparently was the thought that a low pour point would improve the mobility of the oil in the waste and thereby eliminate or decrease the difficulties caused by high retention and adhesiveness during periods of low atmospheric temperature. As already pointed out, viscosity and surface tension are the two characteristics of the oil that affect its retention in the waste above fiber saturation. While the laboratory work has not been completed on the influence that oils medicated with pour point depressants have on their behavior with waste, it appears from the work done and substantiated by the records of bearing heatings since the specifications became effective that the use of depressant additives has materially increased rather than decreased the adhesive powers of the oil and is a factor in the appreciable increase in bearing failures.

To evaluate the overall lubricator and lubrication efficiency of E.M. 906-50 specification car oils, samples submitted by all the major oil companies were tested in the Indianapolis laboratory by the Association of American

Railroads. The results of most of the oils tested in this group are in good agreement.

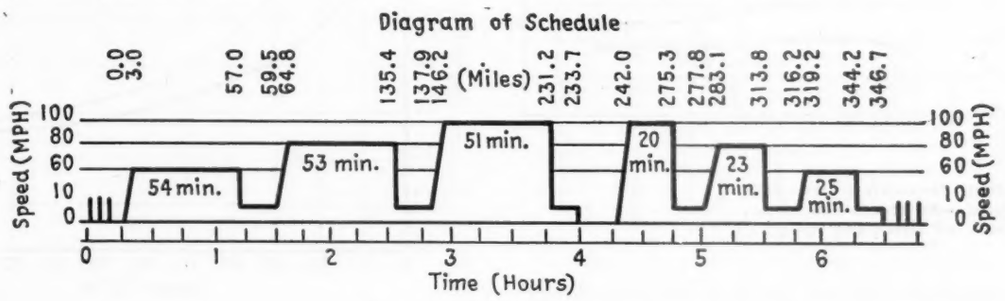
A comparison of the total energy consumed to complete two test cycles for both the sub-zero and high temperature tests for each oil shows an average ratio for the three oils in each group of 14.13 to 19.00 hp. hr. favorable to the light oils for the low temperature tests and 8.37 to 13.03 hp. hr. respectfully for the high temperature tests. Car oils in the current specification range have an uneconomic excess viscosity that is responsible for an unnecessary energy loss of approximately 25 per cent. The heat equivalent to this excess energy is reflected in the greatly elevated journal temperature. For the sub-zero tests the low viscous oils averaged for the three tests at all speeds 68 deg. F. lower journal temperatures than the specification oils, and for the high temperature tests the journal's average was 64 deg. F. below the average temperature of the three heavier oils.

The peaks in hot box curves occur during extremes in atmospheric temperature and in most sections of the country in the summer months. The experimental evidence presented indicates that the practice of using heavy oils in summer to provide a thicker film, and supposedly better lubrication is in reality a direct influence on the high ratio of failures during the hot months. Bearing temperatures are within a range of 10 to 20 deg. for a given oil under like operating conditions regardless of the ambient temperature; that is, a waste packed journal operating in an atmosphere of 100 deg. F. will have a temperature at the end of any operating cycle of only 15 deg. F. higher than when operating in an atmosphere of minus 15 deg. F. Lighter oils are as essential for summer operation as during the colder weather if we are to flatten the peaks and further depress the valleys of the hot box curve.

The question most frequently raised in opposition to lower viscosity car oil is its ability to lubricate satisfactorily in high atmospheric temperatures. However, tests were made of two samples of blended and compounded renovated car oil. The specification oil consists of 90 per cent renovated oil, 10 per cent neutral blending oil, and 0.2 per cent of a pour point depressant. The low viscosity sample contained 50 per cent of the renovated oil, 50 per cent of the neutral blending stock, and 0.5 per cent of an E. P. (extreme pressure) or oiliness additive. The specification oil had viscosity values of 52.1 S. U. S. (Saybolt Universal Seconds) at 210 deg. F. and 301 S. U. S. at 100 deg. F., the low viscous oil, 41.6 S. U. S.

TABLE NO. 1—COMPARATIVE TEST RESULTS OF SIX CAR OILS

5½-in. by 10-in. journal — Speeds—Distance for 36-in. wheel — Journal load—16,375 lb.
Standard A.A.R. babbitt lined bearing broached 5.53125 in. diameter. — Diametrical Clearance .03125
Waste lubricator—All cotton packing waste — Saturation 3½ parts of oil to one part of waste
Oils—Three low viscosity high film strength — Three specification EM 906-50



	+No. 1 Cold	+No. 1 Hot	+No. 2 Cold	+No. 2 Hot	+No. 3 Cold	+No. 3 Hot	+No. 4 Cold	+No. 4 Hot	+No. 5 Cold	+No. 5 Hot	+No. 6 Cold	+No. 6 Hot
Viscosity in Saybolt seconds, deg. F.:												
100	191		310		146		316		128		301	
210	46		53		42		53		42		52	
Average ambient temperature, deg. F.:												
Minimum	−21	99	−30	99	−21	99	−29	99	−31	100	−31	99
Maximum	−12	101	−18	101	−11	101	−15	101	−20	101	−16	101
Total energy consumed two runs hp. hrs.	13.8	8.9	20.6	13.6	14.9	9.7	18.4	13.0	13.7	6.5	18.0	12.5
Average journal temperature end, m.p.h.:												
60	203	217	259	266	215	223	265	276	180	196	244	259
80	230	246	291	302	237	252	299	318	211	223	294	296
100	253	268	318	332	259	274	332	349	232	243	324	329
Maximum journal temperature	269	287	367	354	270	291	352	367	250	258	352	352
Average journal temperature rise end, m.p.h.:												
60	219	117	282	166	230	124	285	117	204	95	266	160
80	244	146	311	201	251	152	317	218	235	182	313	196
100	267	167	337	231	271	173	349	250	234	143	341	229
Maximum journal temperature rise	283	175	386	254	282	190	369	267	272	158	369	250
Average lubricator temperature end, m.p.h.:												
60	132	197	74	167	117	171	65	159	40	162	103	176
80	160	216	108	169	161	204	87	176	59	181	135	199
100	185	250	126	176	179	220	97	186	71	189	141	210
Average resistance lbs./ton DBP end, m.p.h.:												
60	0.87	0.58	1.19	0.81	0.91	0.60	1.10	0.70	0.78	0.41	1.02	0.71
80	0.78	0.54	1.03	0.74	0.80	0.56	0.98	0.73	0.70	0.40	0.92	0.59
100	0.72	0.53	0.96	0.72	0.76	0.57	0.93	0.65	0.65	0.41	0.89	0.66
10	1.64	0.96	2.35	1.99	2.52	1.89	2.83	1.30	0.74	0.23	2.20	1.25
Average temperature:												
Spread bearing and journal	10	4	15	7	7	2	13	5	14	5	10	5
Spread bearing and packing	91	50	160	105	86	54	200	119	80	45	146	80
Spread bearing and box roof	60	20	109	66	78	50	123	74	136	38	119	66
Average starting resistance before test	21	41	33	53	24	39	43	61	31	46	34	66
Average starting resistance after test	61	60	65	72	38	45	84	80	38	46	83	80

+No. 1 Standard Oil of New Jersey, No. W. S. 1543 Oil.
+No. 2 Standard Oil of New Jersey, Esso No. 2046.
+No. 3 Sinclair Alweather No. 313 Car Oil.
+No. 4 Sinclair SINCO Car Oil No. 53.
+No. 5 Railroad Service & Supply Corp., Low Viscosity Renovated Oil.
+No. 6 Railroad Service & Supply Corp., Specification EM 904-50 Oil.

at 210 deg. F. and 127.8 S. U. S. at 100 deg. F.

Each oil was tested at speeds of 10, 30, 60, 80 and 100 miles per hour for 7 hours of continuous running under 16,375 lb. total load in an atmosphere of 125 deg. F. The test room temperature was maintained during the no-running time (17 hours between each test) to assure maximum mobility of the oil during the quiescent period.

In evaluating the two oils on the basis of the stabilized results of the variable factors established by the tests, the divergents of the bearing temperature curves with increased speed and the corresponding position of the draw bar pull curves, Fig. 4, again indicate that lighter car oil is essential in reducing normal journal temperatures during summer operation. This is further substantiated by the close approximation of the viscosity of the two oils at the higher operating temperature, Fig. 5.

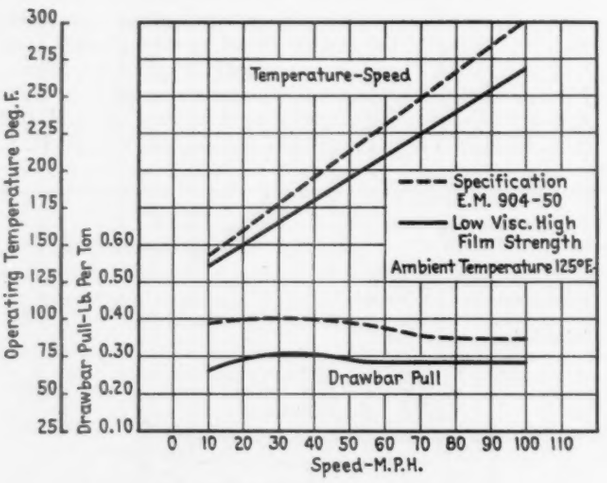


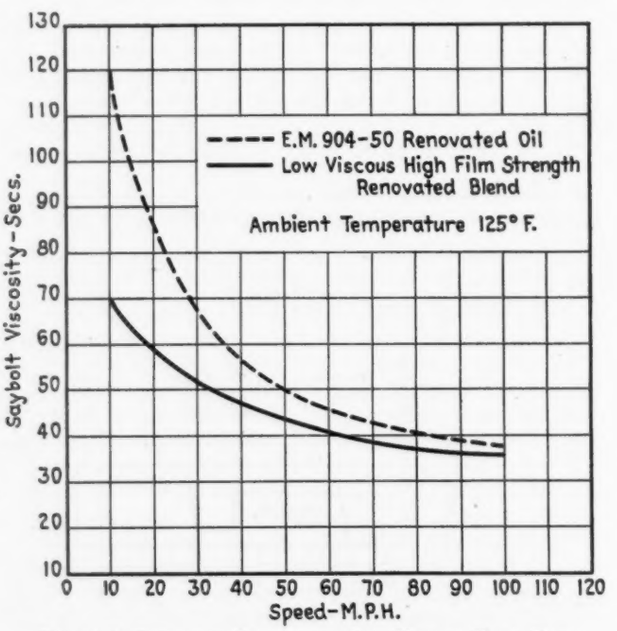
Fig. 4—Operating temperature and drawbar pull compared with speed. Low viscous, high film strength oil versus EM 904-50 oil

The two bearings used in the tests were machined identical in all vital dimensions. Each has a diametrical clearance of .03125 inches. It is therefore assumed that under static conditions the intimate contact between the bearing and journal was identical. At the end of each test covering a total of 1,960 miles, the effective crown area by planimeter measurements of tracings of the worn areas showed that the bearing used with the light oil had a total area of 18.5 sq. in. while the bearing used with the specification oil had an area of 18.3 sq. in. Since the worn area of both bearings was practically identical, the oil film introduced by rotation of the journal was sufficient with either oil to separate the bearing and the journal and permit running with an identical unit load. If the low viscosity oil were not able to support the load under any of the conditions imposed by the test, wear of the contact area of its bearing would have continued until it was large enough to permit an oil film that would carry the load. Since this did not occur, it adds further assurance to the use of lower viscosity oils in hot weather.

An attempt was made to ascertain the relative factor of lubrication safety of the two oils at the stabilized temperature for the 100-m.p.h. speed by measuring the film strength of the oils on a modified Almen type tester. The light oil had a stabilized journal temperature of 267 deg. F. The corresponding temperature of the heavier oil was 296 deg. F. With the test bearing and journal in place and the cellar filled with the oil to be tested, the assembly was heated on an electric hot plate until it reached 310 deg. F. Due to loss of heat during the test cycle, the final temperature of the light oil at the time of film rupture was 240 deg. F., and the oil failed under a load of 70,000 p.s.i. The final temperature of the heavy oil, due to a shorter test cycle, was 250 deg. F., and the failure occurred under a load of 33,000 p.s.i. From this test it appears that the light oil not only maintains sufficient film thickness to support successful normal bearing operation, but has reserve film strength to resist lubrication failures now caused by over load and low speeds.

Journal Box Packing Waste

In June 1949 five series of tests of packing waste fibers were started at the Indianapolis laboratory in an



EM 904-50 Renovated Oil		Low Viscous High Film Strength Renovated Blend	
Viscosity index	94	Viscosity at 100 deg. F.	127.8
Viscosity at 100 deg. F.	301	Viscosity at 210 deg. F.	41.6
Viscosity at 210 deg. F.	52.1	Viscosity index	99

Fig. 5—Oil film viscosity Saybolt Universal Seconds (S.U.S.) of operating temperatures

attempt to evaluate the commercially available threads for its usage value in journal box packing. The work was done on a special four spindle machine, with eight 2¾-in. diameter journals. Various individual type threads, as well as commercial packing waste, were tested and rated on the amount of excess oil fed to the bearing, bearing temperature, oil retention, resilience, tendency to waste and thread grab and rolling.

In the first series of tests conducted to screen various types of materials thirty-one samples of waste and individual threads were studied. The material was divided into sixteen samples of commercial packing waste supplied by various manufacturers of which seven were all cotton; two samples were all wool; and seven samples were miscellaneous mixtures. There were fifteen individual thread types consisting of three types of wool thread, Marino thread, eight different types of cotton thread and three samples of classified rayon thread. In each case the packing was made up of 3½ parts of renovated oil and 1 part of waste.

Of the thirty-one samples studied, all cop cotton thread,

mixed spooler and cop thread, mixed rayon thread and rayon crepe were rejected as unfit for use in journal box packing. The following eight samples were classified as questionable and not recommended for use in packing: Unmachined cotton-warp thread, machined and unmachined cotton spooler thread, machined cotton cop thread, and four samples of commercial cotton packing waste made up predominately of spooler and cop thread. The remaining twelve samples of packing waste and eight samples of classified thread were considered satisfactory for use in journal box packing.

The second group of tests run with seven different packing wastes saturated with renovated oil was made to determine the effect of the natural variance in the ratio of volume to weight of the different packing wastes. As the ratio of volume to weight of packing in the box is decreased, the temperature of the bearing is reduced, the oil fed to the journal decreases, and the other functional characteristics of the packing remain essentially unchanged.

The third series of tests using seven different waste packs were conducted to determine the effect of varying amounts of moisture in the packing. Each waste was tested first, as removed from the bale; second with 10 per cent of additional water; and third oven dried (oven drying resulted in an average moisture loss of 8.2 per cent of the weight of the samples). The oven dried packing produced an average bearing temperature rise of 13 deg. above that obtained with the waste as removed from the bale and the hydrated packing averaged 20 deg. F. below the bearing temperature of the dehydrated packing. The oil fed to the bearing was essentially the same for the waste as received, and the waste to which 10 per cent of water was added; while water drying the waste somewhat lowered the feeding rate.

The fourth series of tests were conducted to determine the behavior characteristics of oils from different sources when saturated into packing waste of widely different thread mix. (Fig. 6 is typical example of three oils in cotton waste.) There were five types of commercial packing waste used including one sample each of all wool; 60 per cent wool, 40 per cent cotton; 30 per cent wool, 35 per cent cotton warp, and 35 per cent fine cotton slasher; 95 per cent cotton thread and 5 per cent cocoa fiber; and a manufactured brand all-cotton packing waste. Each of the above samples was made into a six waste pack lubricators using a different oil for each. Five of the six oils used had a viscosity range of from 52 sec. to 61 sec. Universal Saybolt at 210 deg. F. and the sixth sample was winter car oil with a viscosity of 45 sec. at 210 deg. F. From a standpoint of the waste the results of this study again indicate that resilience is a criterion of bearing temperature rise. The wool and wool mixtures operate with an average temperature differentiation of from 5 deg. to 7 deg. F. above the cotton waste packing, Fig. 7.

From a comparative study of this series of tests it appears that the rate of oil feed to the journal is independent of the initial viscosity of the oil tested, the rate of feed being indirectly influenced by the effect of oil viscosity on operating temperature. It is apparent that in the viscosity range of the oils tested, the other functional characteristics of the packing depend more on the type and condition of the waste than on the oil. The all cotton waste had the highest rate of oil feed and the wool-cotton mixture the lowest, Fig. 7.

The fifth series of tests to compare the functional behavior of straight mineral car oil with oil containing oiliness or film strength additives employed six different samples of packing waste consisting of all wool, all cotton, and composite samples of both materials. Each kind of the above waste was made into six lubricator packs three of which were saturated with non-additive car oils of conventional physical dimensions, and three packs saturated with E.P. additive oils having a lower viscosity range. The comparison of the non-additive oils with the medicated oils, using the average of the six lubricating packs with the six oils, shows that the additive oils operated at a lower temperature, had better feeding ability, and do not as readily carry waste fibers and threads to the bearing.

From the results of the foregoing five series of investigations the following conclusions were made:

1. All types of waste threads and combinations thereof will feed oil to the journal in excess of that necessary to support full fluid film lubrication.

TABLE NO. 2—COMPARATIVE TEST RESULTS OF TWO RENOVATED CAR OILS

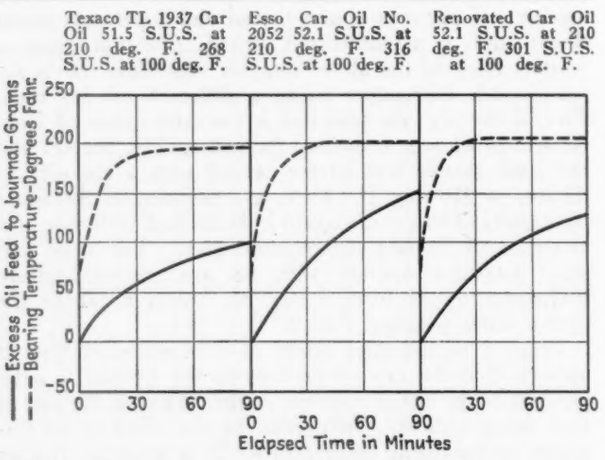
5½-in. by 10-in. Journal. Speed-distance for 36-in. wheel. Journal load, 16,375 lb.
Bearing A.A.R. standard babbitt line broached 5.53125 in. Diameter. Diametrical clearance, .03125 in.
All cotton packing waste Saturation 3½ parts oil—1 part waste.

Test No. 1—Renovated Car Oil, Low Visc. High Film Strength

	10 m.p.h.	30 m.p.h.	60 m.p.h.	80 m.p.h.	100 m.p.h
Temperature, deg. F.:					
Ambient	126	125	125	125	125
Journal	135	168	216	242	267
Bearing	135	168	215	242	266
Box Roof	131	149	180	197	213
Packing	131	155	188	206	220
Temperature rise, deg. F.:					
Journal	9	43	91	117	142
Bearing	9	43	90	117	141
Box roof	5	24	55	72	88
Torque, lb.-in.	40	45	43	42	42
Total energy loss, hp. hrs.	0.41	1.40	2.67	3.48	4.35

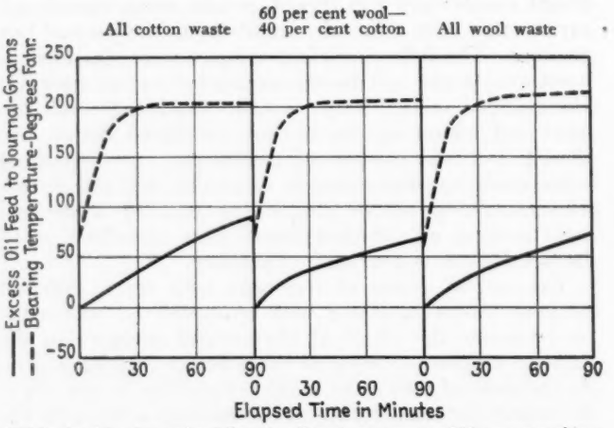
Test No. 2—Renovated Car Oil, Specification E.M. 904-50

	10 m.p.h.	30 m.p.h.	60 m.p.h.	80 m.p.h.	100 m.p.h.
Temperature, deg. F.:					
Ambient	125	125	125	126	126
Journal	138	182	237	268	296
Bearing	138	182	235	265	293
Box roof	134	161	198	217	233
Packing	132	156	185	195	202
Temperature rise, deg. F.:					
Journal	13	57	112	142	170
Bearing	13	57	110	139	167
Box roof	9	36	73	91	107
Torque, lb.-in.	56	59	56	52	49
Total energy loss, hp. hrs.	0.58	1.83	3.48	4.31	5.08


Texaco TL 1937 Car Oil 51.5 S.U.S. at 210 deg. F. 268 S.U.S. at 100 deg. F.
Esso Car Oil No. 2052 52.1 S.U.S. at 210 deg. F. 316 S.U.S. at 100 deg. F.
Renovated Car Oil 52.1 S.U.S. at 210 deg. F. 301 S.U.S. at 100 deg. F.
Excess Oil Feed to Journal-Grams
Bearing Temperature-Degrees Fahr.
250
200
150
100
50
0
-50
0 30 60 90 0 30 60 90 0 30 60 90
Elapsed Time in Minutes

2-¾-in. by 5-in. journal; all cotton waste; 3.5 parts oil to 1 part waste; 563 grams packing per box; 50-lb. journal load; speed 934 r.p.m.; average of eight journals

Fig. 6—Comparative average tests and bearing temperatures of two EM 906-50 oils and one renovated oil



2-¾-in. by 5-in. journals; 3.5 parts oil to 1 part waste; 563 grams packing per box; 50-lb. journal load; speed 934 r.p.m.; average of eight journals

Fig. 7—Comparative average oil feed and bearing temperature of straight renovated oil — 52 S. U. S. at 210 deg. F.; 359 S. U. S. at 100 deg. F.

2. All car oils in the viscosity range tested will feed sufficiently to satisfy lubrication with any waste combination.
3. Artificial fibers are detrimental in packing due to extreme fineness of the fiber which are readily carried on the journal.
4. The addition of wool to packing waste mixtures improves most of the operating characteristics of the packing lubricator, with the notable exception of bearing temperature.
5. The degree of machining and, therefore, uniformity of material has a pronounced influence on the operating characteristics of the waste packing.
6. Bearing temperatures are proportional to the tightness of the packing against the journal.
7. With identical quantities of oil and waste in the pack, oil feed to the journal is inversely proportionate to the tightness of the waste pack.
8. Moisture content of packing has a beneficial influence on its operating characteristics, and
9. E.P. additive oils have better operating characteristics than straight mineral oils.

From the foregoing we can conclude that the three types of material covered by specification EM 905-50 represent the best available packing waste of their respective kind.

In the practice of waste packed lubrication there has always been a difference of opinion as to whether cotton or wool waste was the better vehicle in journal box packing. There are certain fundamental differences between the materials that give to each some advantages over the other. Cotton fiber is a single cellular vegetable seed hair that can be briefly described as a thin hollow tube. Wool fiber is the shaft or non-living hair of the sheep and is a tough, horny growth with a cellular marrow resembling a honeycomb. This structural difference gives to cotton a residual fiber saturation when subjected to a centrifugal force of approximately 40 atmospheres and at a temperature of 250 deg. F. of approximately 30 per cent. Wool under the same treatment will de-oil to from 10 per cent to 15 per cent. The ability of wool to give up its oil more readily and to a lower degree of saturation gives it some theoretical advantage. It has been pointed out, however, that all types of waste thread and combinations thereof will feed considerable excess oil to the journal even when the ratio of oil to waste in the packing has been reduced from 3.5 to 1 to 2.75 to 1. Wool having less affinity for water than cotton, the moisture coalesces more rapidly and settles to the bottom of the box; while cotton, having a greater affinity for water, will retain more in the fiber. In the hot summer months this is a decided advantage in lowering packing resilience and the friction of the packing against the journal.

Because wool gives up its oil more readily than cotton (increased resilience), absorbs less water than cotton (maintains resilience), and has a hard surface structure which generates more friction against the journal than cotton packing, it appears from a lubricating standpoint that the lowest possible journal temperature and, therefore, better lubrication is best assured with all cotton waste. From a functional standpoint wool has less tendency to roll and to produce thread risers and waste grabs than cotton. This can be contributed more to the relatively large diametrical cross section or gauge of the yarn as compared to the cotton thread being furnished currently in cotton waste than to any basic difference in the materials. By far the majority of new cotton waste being saturated into packing is extremely fine, hard and soft slasher heavily machined. The theads are of such a fine gauge that it is difficult to start the test machine under normal room temperature, particularly when using oil containing a pour point depressant, without carrying threads to the bearing.

Recognizing that good cotton packing waste is in extremely short supply, no doubt influenced somewhat by the expanding use of waste in Diesel filters, with its reflection on price, the author believes that the time may be here from a psychological, economic and lubrication efficiency standpoint to turn to a cotton cord of the proper ply and thread gauge specifically designed as a packing material to replace waste in journal boxes. We have done considerable work in the laboratory and are conducting some studies on the railroads with several sizes of cotton cords both as loose packing and captured into pad form with very encouraging results. Packing lubricators made with specification cord have considerably less energy loss in journal friction, resulting in far less lubricator displacement in the box and, therefore, requires a minimum of attention and servicing. Because the material feeds several times more oil than the best

available packing waste, it approaches flood lubrication which gives it considerable lubrication advantage over waste packed lubricators; and, due to its uniform ratio of weight to volume, cord size and length of thread, it has many physical advantages over waste that assures overall reduction in both direct and indirect lubrication costs.

Packing Renovation and Preparation

There are approximately 250 million pounds of journal box packing in the packing pool on the Class I railroads with a current replacement value in the neighborhood of twenty-five million dollars. It is obviously an economic necessity to reclaim this material after its prescribed period of service, and to restore its usefulness by renovation. Prior to instituting A. A. R. specification E.M. 910-50 for renovated waste and packing, renovation was generally accepted and considered to be an economic practice only. The effectiveness of a renovating plant was in too many cases measured by the cheapness of the process, and the value of the product was often weighed only in the scale of visual inspection, little attention being paid to its usage value as an efficient lubricant. While an honest effort was continuously being made on some railroads to improve their lubricating materials and maintain uniformity by laboratory control. It was impossible to elevate renovation to its potential possibilities in the face of the cost barriers of cheap reclaiming practices and because of the immediate submergence of good packing in the vast pool of inferior material.

With the advent of the tighter specification for renovated journal lubricating materials, it became evident that while cleaning oil and waste became a far more exacting job, it also became but one step in the function of the renovating and preparation plant if renovation of packing was to become a fact as well as a name. For, to produce uniform specification packing not only required additional steps in the process of cleaning, but additional preparation of both the oil and waste after cleaning and before saturation into packing.

It is recognized and accepted that oil extracted from dirty packing can be commercially renovated by chemical methods and returned to like service meeting all the physical constant specifications of the all-mineral car oils from which it originated. The more important specification items are remarkably uniform throughout the year and regardless of geographical location. Its behavior in service or lubrication value is high and is of like dependability. Its one shortcoming, like new oils of similar characteristics, is a functional defect when used in waste due to a viscosity temperature curve that, under certain operating and temperature conditions, retards its mobility in waste resulting in periods of increased adhesion of the packing and the journal and a possible cause for failure.

Since the renovated oil, as produced, has good uniformity within the limits of commercial oil specification, it can be blended with a compatible neutral oil to meet practically any theoretically possible physical dimension specification to overcome its defection when used with waste. Any reduction in the lubrication factor of safety of the blended oil which would occur in the boundry film region, can be restored and improved by the addition of oiliness or film forming additives.

On the railroads using low viscosity, high film strength oil in extensive operating tests, the renovated oil, as produced, having an approximate viscosity of 54 S. U. S. at 210 deg. F. and 360 seconds at 100 deg. F. with a viscosity index of 84 is blended with 50 per cent of a 57 neutral oil, producing a finished oil with a viscosity of 41.6 seconds at 210 deg. F. and 127.8 seconds at 100 deg. F. with a viscosity index of 99. To the blended oil is added 0.5 per cent of an E.P. compound. The temperature-viscosity chart, Fig. 8, emphasizes the flatness of the curve produced from the blend of two oils, one having a very low viscosity index. The depressed viscosity in the temperature range below 100 deg. F. is the added factor of safety to the waste pack lubricator by the increased mobility of the oil over the temperature range where the hazards of packing lubrication are the greatest.

It is recognized that the renovation of car oil has advanced to a point where there is no necessity to differentiate between or to provide separate specifications for both new and renovated oil. The renovation of car oil is a positive scientific process while the cleaning of dirty waste is decidedly less positive and infinitely more difficult of accomplishment.

There are many types of packing cleaning and preparation plants producing materials that cover the whole range of quality from materials definitely unfit for service to renovated packing of superior quality. Renovation of journal packing involves the cleaning of two dissimilar materials, one a liquid (contaminated oil) and one a solid (contaminated waste). The first basic step, therefore, is to separate the components of the packing in order to subject each to its best possible medium for cleaning.

In order to produce specification or better renovated waste and packing it is fundamental that, since the oil is regenerated by a chemical process and the waste is cleaned by mechanical means having no effect on the oil, the less residual dirty oil remaining in the fiber of the waste, the cleaner the waste will be, and the less deleterious fine dirt will be found in the finished packing.

Because the final degree of cleanliness of the waste depends to a large extent on the oil and water dryness of the material, if the above basic steps in the renovating of dirty packing are adequately performed, the subsequent step of efficiently removing the extraneous heavy solids together with the short fiber, knots, lumps, balls, etc., can be effectively carried out by mechanical means and preferably in the presence of a strong blast of hot air.

The one remaining and necessary machining operation to waste before resaturation into packing is some mechanical means of intermingling new and renovated thread simultaneously with combing or carding the material to resolve the remaining snarled waste in order further to eliminate short fibers from both the new and renovated material. Fig. 9 graphically illustrates comparative bearing temperatures and excess oil fed to the bearing for new cotton waste, specification renovated waste, and renovated waste that received an additional wash in clean oil. The higher operating temperature of the special renovated material is due to the complete water dryness of the packing which results in an increased volume to weight ratio and excess resilience.

The journal box packing renovating and preparation plant is the heart of car journal lubrication. While the ability of a plant or process to produce a clean and uniform product is the responsibility of the owner railroad, the influence that the material thus produced has on the performance records, as a whole, suggests that the problem could be profitably made a matter of A. A. R. decision and certification on the adequacy of every renovating plant to produce journal box packing to a minimum universal specification. Until such time as reasonable uniform lubricating materials and practices become a fact, as well as a specification, we will continue to have a car journal lubrication problem instead of a successful lubricating practice.

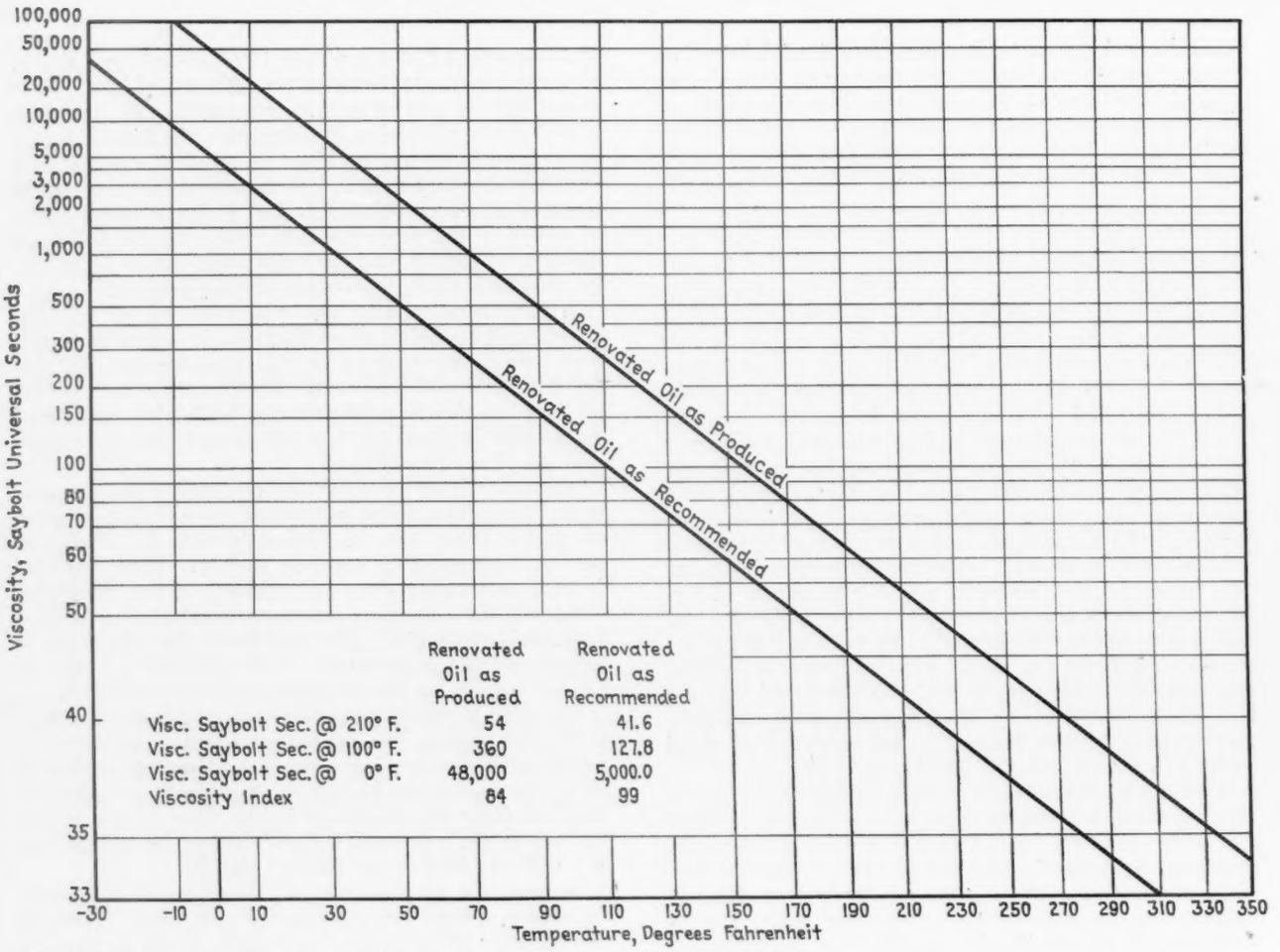


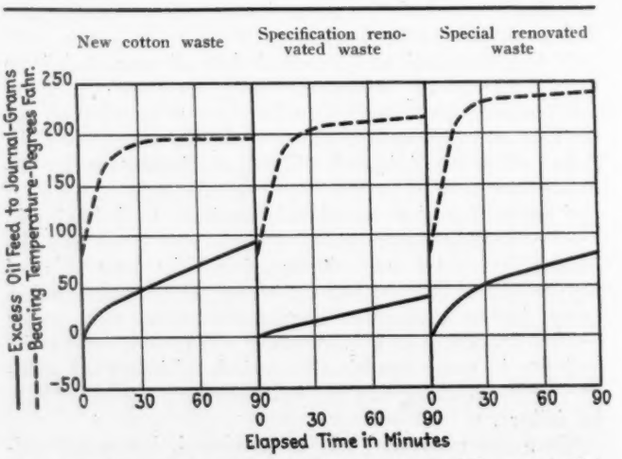
Fig. 8—Viscosity-temperature chart of renovated car oil as produced and as recommended

Conclusions

In order to protect the railroad's investment in the solid type journal bearing and continue the use of the efficient conventional bearing assembly, it is paramount that the present system of indirect self lubrication be brought to its highest potential possibility or give way to some more costly and complicated methods of lubrication. The barrier to elevating the efficiency of the waste pack lubricator is not primarily technological. The program outlined in this paper, while supported by well authenticated data from both the laboratory and the railroad, is in disagreement with the opinions of many railroad mechanical men. It appears to be the human rather than the technical phase of the problem that offers the greatest challenge to the A. A. R. committees charged with the responsibility of improving journal lubrication. There is available to them a wealth of technical information on the subject of journal operation and lubrication.

On the basis of present information the following conclusions are recommended for consideration:

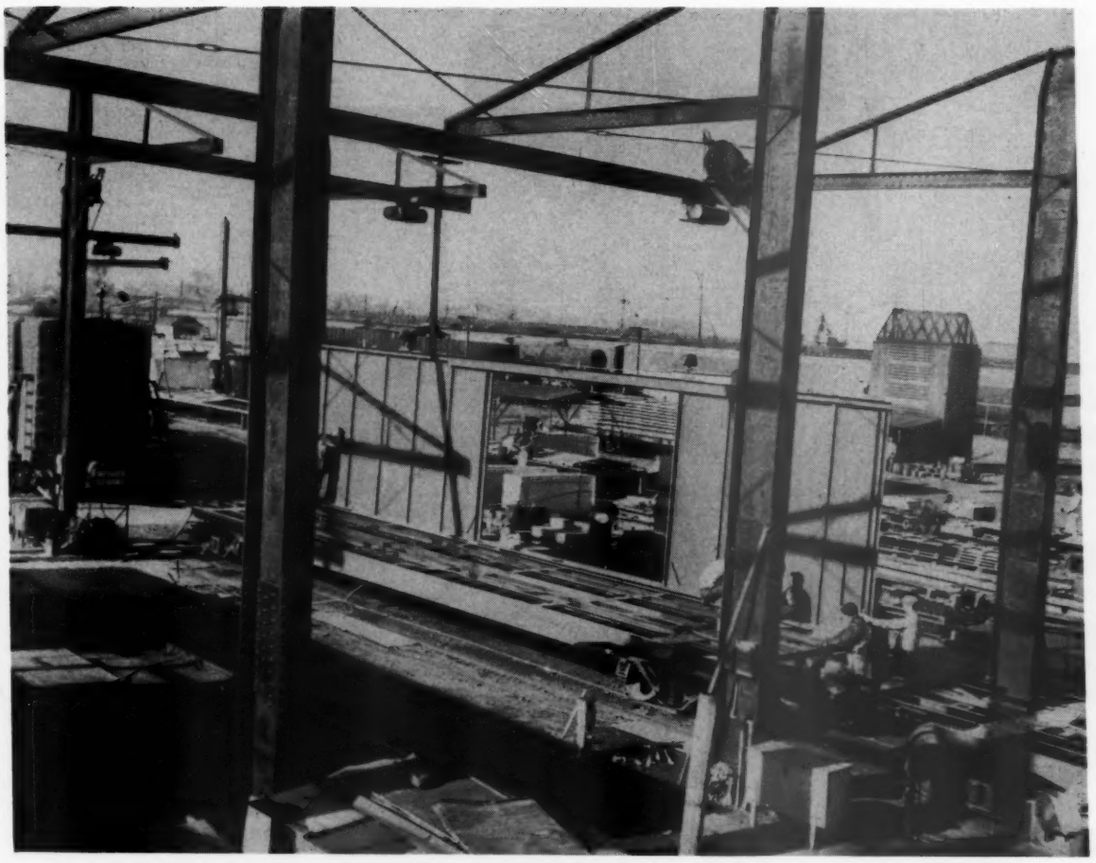
1. Low viscosity car oil reduces the inherent hazards of waste packed lubricators.
2. Car oils in a viscosity range of 40 to 42 S. U. S. at 210 deg. F. with an oiliness or film forming additive are capable of lubricating railway car bearings under extremes of atmospheric temperature, heavy loads, and high speeds with low stabilized temperatures.
3. Fine thread comprising the majority of new cotton waste is producing lubricating failures by increasing the hazards of waste packing.



2-¾-in. by 5-in. journals; 3.5 parts oil to 1 part waste; 563 grams packing per box; 50-lb. journal load; speed 934 r.p.m.; average of eight journals

Fig. 9—Comparative average oil feed and bearing temperature of low viscosity renovated oil—41 S. U. S. at 210 deg. F.; 116 S. U. S. at 100 deg. F.

4. That cotton cord made specifically for journal box packing be exhaustively investigated.
5. The specifications for renovated waste and packing be reviewed and revised to improve its quality.
6. A system of A. A. R. control by certification of packing renovation and preparation plants be considered as a means of elevating the quality of all journal box packing to a common denominator.



Dual mono-rail hoists are used to apply steel sides, in this instance to an auto-box car

Shop Kinks Help in Building Box Cars

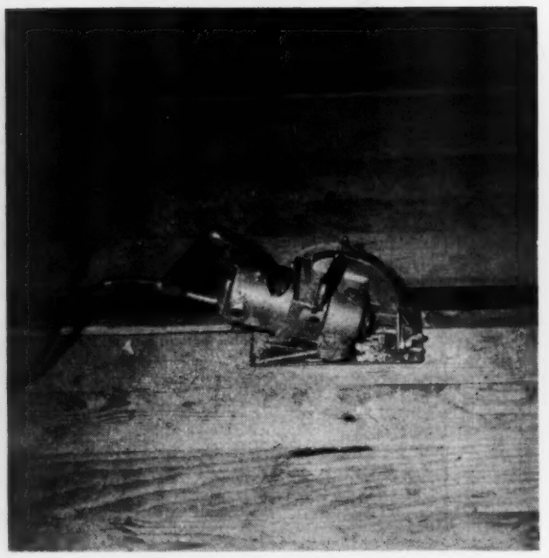
A FEATURE of the freight-car building program of the Southern Pacific at Sacramento, Calif., is the extensive use of straight line production methods and special layouts and equipment designed to expedite work at the various positions. The kind of job done is indicated by the accompanying view of a modern 50-ton box car having a light weight of 44,000 lb. and turned out of Sacramento shops in October 1951. On cars of this type, the production line moves every 25 min. and the output averages 15 cars a day.

Climatic conditions at this shop are generally favorable to outside work, some details of which are shown in the illustrations. At the position where car sides are applied, for example, heavy vertical steel I-beams and A-frame extensiones at the top, support two monorails and electric hoists which are power operated across adjoining tracks about 20 ft. above ground level, or high enough for handling car sides into position on underframes. Crane hooks engage the tops of the prefabricated car sides (one at a time) on either side of the doorways and they are easily lifted from the specially equipped flat car used to bring them to Sacramento shops. In each instance, the hoists are then traversed to the underframe on the adjoining track and a pair of car sides bolted and braced lightly in place.

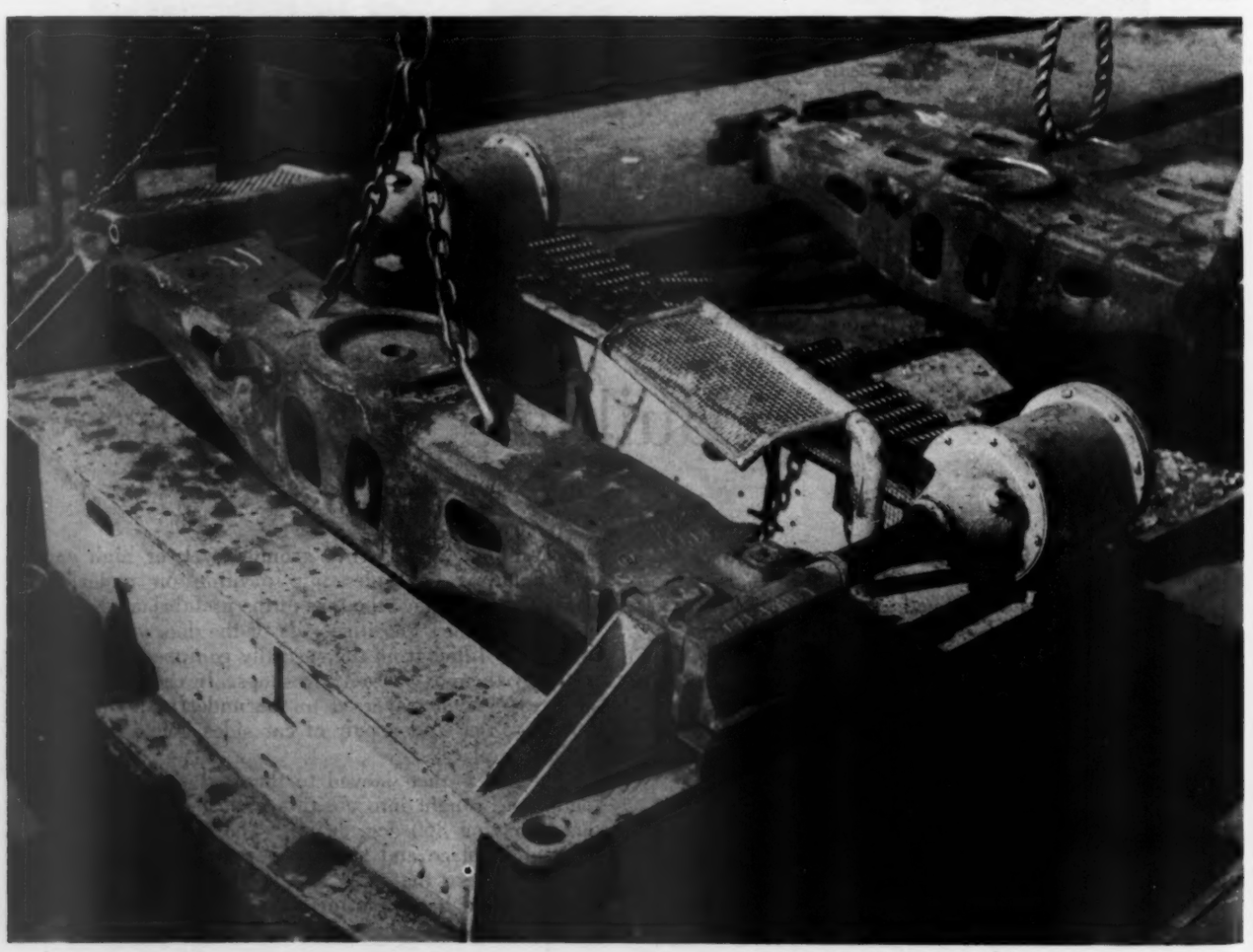
The car is then moved to the next station where the ends are brought into position with a hoist-equipped jib crane having 360 deg. swing. The ends are bolted and pinned in place and the car is moved under a riveting scaffold where the sides and ends are riveted together. This scaffold has a platform which is lowered by means of an electric push-button control to the inside of the car

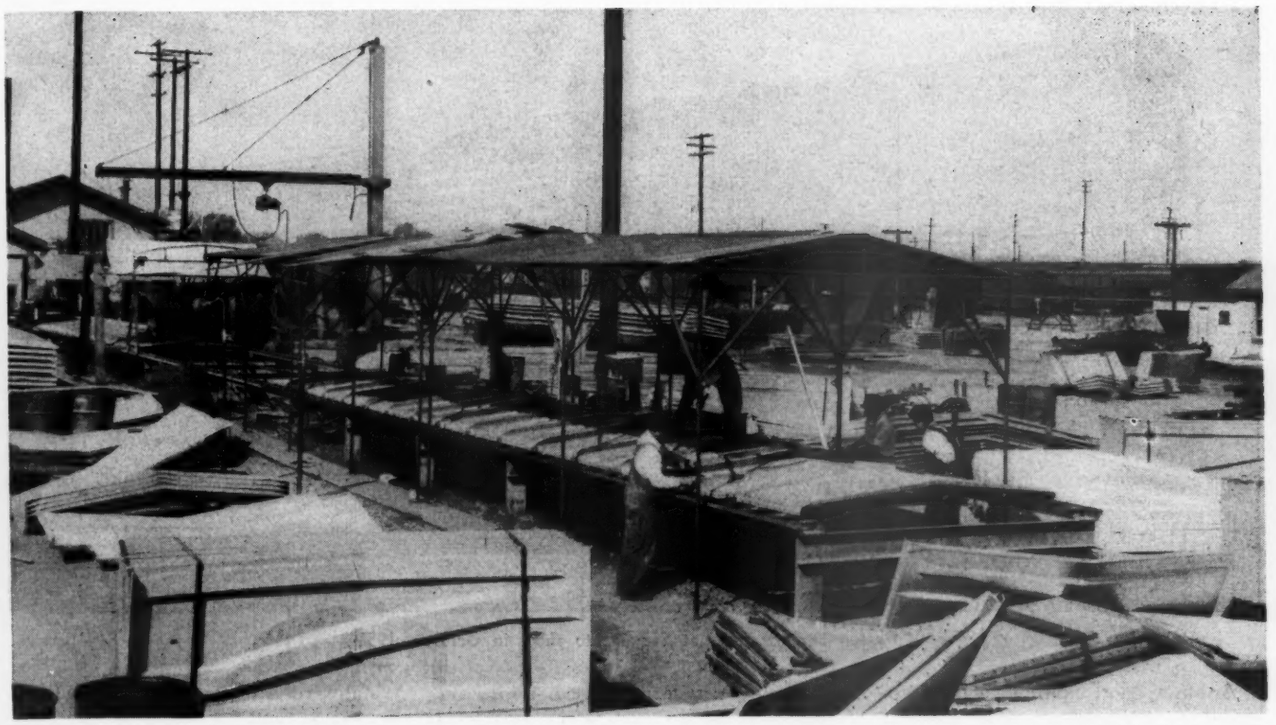
Light but strong steel supports for vertically adjustable inside and outside end-riveting platforms

Portable electric tool cutting mortises for the flanged edges of steel doorway perforated protection plates



Double-acting pneumatic press for assembly Ride-Control bolsters, springs and friction castings





Roof-fabricating position, part of which is covered. Rollers permit easy assembly of sections and movement to riveting spot

and from which the riveter works. At the same level on the outside of the car is another platform for the bucker, rivet heater and forge. Vertical travel of the two platforms is controlled from the riveter's position. The movable platforms can be raised high enough for cars to pass under. The motor, gears, pulleys, etc., are located on a stationary platform at the top of the scaffold.

Assembling Car Roofs

The car roof is purchased in sections which are assembled on a table equipped with rollers for easy longitudinal movement of either individual sections or the completed roof in the course of being fabricated. The table is given overhead protection at the assembly position by corrugated metal sheathing supported on a light steel frame work. The end and inter-roof sheets are first placed in position on the table and the carlines located over the joints. Pins are inserted in a few of the rivet holes and annealed rivets in the others. The rivets are set cold with a Chicago Pneumatic portable hydraulic riveter. supported from a light gantry crane which operates up and down the uncovered portion of the table as required. The running board is applied and bolted down with a pneumatic wrench. The finished roof is then placed on a flat car on an adjacent track, using a jib crane. During a car-building program sufficient roofs are assembled each day to keep one full day ahead of the main car assembly line.

A good example of how time and labor are saved in assembling freight cars at Sacramento shops is afforded by the device used to apply friction castings and springs to the bolsters of A. S. F. Ride-Control Trucks. After the friction castings are forced into the bolster pockets under spring pressure by the action of two air cylinders and pistons, retaining pins are inserted to hold them in place until the bolster is assembled in the truck side frames. Removal of the pins then allows springs to force

Hydraulic riveter used in cold riveting roof sections together at the carlines

the friction castings out against the side frames and serve to break up harmonic spring oscillation under road service shocks.

While pressure is being applied in this device to the friction castings, heavy wire mesh safety guards are swung into position over them to afford protection to workmen in case the pressure should be released for some reason before the retaining pins are applied. One illustration shows a safety guard in application position with one swung out of the way for better visibility.

Fifty-ton box car built at Sacramento shops in October, 1951

Another good example of the type of hand tool which expedites the considerable amount of wood work in building box cars is the power mortising machine. This machine is used to mortise a ½ in. by ¾ in. deep groove in the floor of box and auto cars for bent-down edges of the perforated steel floor protection plates, applied between doorways. A standard Model 77 Skilsaw with a Model 500 Jet Jr. dado and moulding blade is used. A ⅜-in. by 2-in. steel strip is nailed to the floor for a guide.

By this method, the mortises are accurately located and cut to the correct size with a minimum loss of time. The doorway protection plates fit on first application.

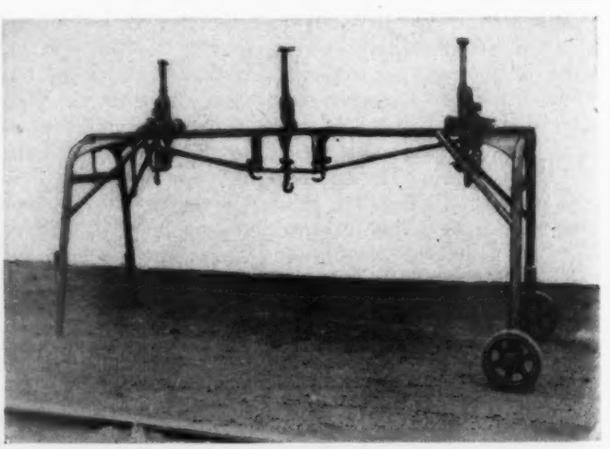
Improved Truck A-Frame

An improvement over the usual type of truck A-frame found on nearly all rip tracks has been devised by the Toledo, Peoria & Western. The A-frames used on this road have a total height of only 52 in. above the ground and are more easily moved about the yard.

The lower height of the A-frame is made possible by the use of ratchet jacks and the manner of mounting the jacks. The center jack for the bolster is a Simplex No. 324 and fits through a slot in the top member of the frame, the slot being shaped to mate with the lift shaft of the jack. The end jacks are Simplex No. 42's and are welded to the frame of the small four-wheel dollies on which the jacks move back and forth along the jack track.

The A-frame rides on two stub-axle wheels 3 in. by 12 in. The handles for moving the A-frame are on the end opposite the wheels and consist of two 14-in. lengths of ¾-in. pipe.

The framing on both ends is of 1½-in. pipe, built up on the wheeled end at the bottom to receive the stub axles. Both ends are reinforced by a horizontally placed length of strap iron ¼ in. by 2 in. located 10 in. below the top. The supports between the end frames and the



This A-frame, designed for easy movement throughout a yard, has a total height of only 52 in.

jack track are angles ¼ in. by 1 in. by 1 in. The jack track is either built up of two angles of this size or made of extra-heavy 1-in. square pipe. Additional reinforcement on the corners is of ¼-in. plate. The two truss rods are ⅝-in. in diameter and the dolly wheels are 1¼ in. by 3 in. The dollies have small handles to move them with the truck sides in place. Suitable holders are incorporated on the frame for carrying the jack handles.

QUESTIONS AND ANSWERS

Diesel-Electric Locomotives*

Duplex Fuel Filter

358-Q.—Where is the duplex fuel filter located? A.—Between the fuel storage tank and the booster pump at the free end of the diesel engine and is mounted on the lower casing.

359-Q.—What does it consist of? A.—Two shells containing filtering elements in the form of replaceable cartridges containing a pound of filtering material.

360-Q.—Are both elements constantly in use? A.—No. The fuel filter handle controls the flow of fuel through either one of the elements or both.

361-Q.—Describe the handle positions. A.—With the handle in a horizontal position one element is in use; vertical, both elements are in use. With the handle in 45 degree position no fuel will flow through the filter.

362-Q.—What is the normal position of the handle? A.—Horizontal position, with one element in use.

363-Q.—What is the advantage of this arrangement? A.—One filtering unit may be used at a time, which allows replacement of the other element during engine operation.

364-Q.—When should the handle be changed to divert the flow of oil to the other cartridge? A.—If there is a gradual drop in fuel pressure, the indication is that the element in use is plugging up and the handle should be moved to the opposite horizontal position, the handle pointer indicating the element in use.

365-Q.—What is the first step to be taken when cleaning the filter? A.—Unscrew the drain plug and drain the filter to prevent spilling oil when withdrawing the cartridge.

366-Q.—What then must be done? A.—(1) Remove cap screws that secure filter shell to cover support and separate shell from cover; (2) Lift out the filtering element, remove its cover and pull out waste or cartridge; (3) Thoroughly clean shell and filter element; (4) Push new cartridge down until it hits bottom of filtering element or repack with good filtering material whatever the case may be; (5) Replace cover on element and re-install in filter shell; (6) Replace cover gasket if necessary, using old one if in good condition. Place filter shell up in cover and tighten cap screws.

Fuel Booster Pump

367-Q.—How many types of fuel booster pumps are in service? A.—There are two types: (1) 1725 r.p.m.-3-g.p.m.-50 p.s.i. (2) 3450 r.p.m.-3?g.p.m.-50 p.s.i.

368-Q.—What does the assembly consist of? A.—An electric motor, driving a gear type fuel booster pump through a flexible coupling on one end of its shaft and a gear type governor oil pump through another coupling on the other end of its shaft.

369-Q.—Describe the pump and its operation. A.—Power is applied to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by a crescent shaped projection. As the teeth come out of mesh, there is an increase in volume which creates a partial vacuum. Liquid rushes into the pump to fill this vacuum and stays in the spaces between the teeth of both the idler and rotor until the teeth mesh. Liquid is then forced from these spaces and out of pump.

370-Q.—Where are the brushes for the motor located? A.—At the fuel pump end of the motor.

Felt Disk Type Fuel Filter

371-Q.—Where is this filter located? A.—On the discharge side of the booster pump at the free end of the diesel engine and mounted on a plate supported by the lower casing.

372-Q.—What does the filtering material consist of? A.—The filtering material consists of a number of felt discs assembled on a steel tube strainer.

373-Q.—Should the filter be cleaned while the diesel engine is running? A.—This procedure must not be attempted while the engine is running.

374-Q.—What should be done first? A.—Remove drain plug from filter housing and drain fuel. Remove cap screws that secure filter housing to cover support and separate housing from cover.

375-Q.—What should be done next? A.—(1) Lift out felt cartridge, dip in fuel oil or kerosene, hold hand over the bottom hole, insert air hose in top hole and blow out. Repeat this process six or seven times. (2) If the cartridge has been used over a long period of time and is found excessively dirty, replace with new cartridge. (3) Re-install new or cleaned cartridge in filter housing. (4) Inspect cover gasket and renew if necessary. Replace filter housing in the cover and securely tighten capscrews.

* This series of questions and answers relate specifically to the Alco-G. E. Diesel electric locomotives.

Steam Locomotive Boilers

By George M. Davies

Stress Relieving Temperatures

Q.—What are the temperature ranges for stress-relieving all welded boilers?—R.F.K.

A.—The A.S.M.E. Code for Power Boilers provides:—Stress-Relieving—Except as specifically provided otherwise in the Code, all fusion-welded pressure parts of power boilers shall be stress-relieved. It shall be done by heating uniformly to at least 1100 deg. F, and up to 1200 deg. F or higher, if this can be done without dis-

tortion. Different temperatures may be used to obtain proper stress-relieving when required by the characteristics of the material. The structure or parts of the structure shall be brought slowly up to the specified temperature and held at that temperature for a period of time proportioned on the basis of at least one hour per inch of thickness and shall be allowed to cool slowly in a still atmosphere to a temperature not exceeding 600 deg. F.

This practice is generally adhered to in the stress-relieving of all-welded locomotive boilers and all-welded boiler shell assemblies.

Tensile Strength of Plates

Q.—The A. S. M. E. Code covering the Rules for Construction of Boiler of Locomotives Section III Paragraph L-11 provides:

"In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plate shall be that stamped on the plates as provided for in Specification SA-70, which is the minimum of the stipulated range of 55000 p.s.i. for all steel plates, except for special grade having a lower tensile strength."

Should this paragraph be interpreted as providing that 55000 p.s.i. must be used in the formulae for computing the maximum allowable working pressure, irrespective of the tensile strength of the material, i.e., a material of higher tensile range than that of 55000.65000 as provided for in Spec. SA-70?—F.E.L.

A.—In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates. In the case of Specification SA-70 which has a tensile range of 55000-65000 p.s.i. the minimum of 55000 p.s.i. should be used; however, in the case of steel having a higher tensile range such as steel to Spec. SA-203, which has a tensile range 65000-70000 the minimum tensile 65000 p.s.i. should be used.

Machining New Dome

Q.—What is the proper method of handling a one-piece flanged dome for machining and drilling; the new dome was received blank from the builders?—F.E.M.

A.—The first operation in preparing a one-piece flanged dome for application to the shell is to lay out and drill the rivet holes in the base flange for the shell connection.

A thin metal half template of the rivet arrangement is made from either the boiler drawings or taken from the shell course. The template is clamped to the inside surface of the base with the template center in line with the dome center line. The rivet hole locations are then center punched directly on the base. The dome center line is identified by two small indentations made on the under side of the base flange, by the holding die, during the flanging operation.

The holes are drilled on a radial drilling machine with the bottom surface of the base facing the drill. The dome is often moved on the table so the holes will be drilled radial to the boiler shell.

The template outside should allow $\frac{3}{8}$-in. stock on the dome base to be milled off. The excess material is burned off for the milling operation.

The next operation is to cut the opening in the top of the dome and counterbore the top surface around the opening for the copper gasket between the dome and the cap if gasket is to be used. These two operations are done in a boring mill. Two cutting tools are necessary for cutting the opening. Tho follower tool should have a slightly narrower cutting edge to prevent the lead tool from binding.

A drilling gage is used for drilling the dome cap stud holes in the dome and the dome cap, milling the edge of the dome base completes the dome for riveting to the boiler shell.

Schedule 24 RL

Air Brakes

Train Control Operation

1239-Q.—After the handle is placed in the application zone what should be done?

A.—Open the cock at the NS-1 reducing valve to release the brake and recharge the system. Move the SA-2 brake valve handle to release position.

1240-Q.—Suppose that the brakes fail to release after a short interval?

A.—In this case it may be necessary to make an emergency application by opening the conductor's valve to reduce an overcharge of the auxiliary and emergency reservoirs.

1241-Q.—In the event that the D-24 Control valve is equipped with a controlled emergency cock, how should the handle be placed?

A.—In *P* position.

1242-Q.—What should be done when the A and B units are re-assembled and the control transferred to the A unit?

A.—It should be noted that the cut-out cock at the NS-1 reducing valve and the SA-2 brake valve are closed, all end hose connected and cocks open.

Procedure For Changing Operating Valves

1243-Q.—When about to change any operating valves or devices, and the main reservoirs are charged, what should first be done?

A.—Place the automatic brake valve handle in emergency position, leaving it there. Depress independent brake valve handle in release position, rotair valve in "PASS" position until auxiliary and emergency reservoirs are drained.

1244-Q.—What next should be done?

A.—Close the equipment cut-out cock (side vented) located in the main reservoir pipe between the brake equipment and the last main reservoir.

1245-Q.—What procedures should be followed after the devices are changed?

A.—The equipment cut-out cock should be opened before brake valve handle is put in charging position.

1246-Q.—What precaution should be taken when there is no attendant in the cab?

A.—The independent brake valve should be left in the application zone when no attendent is in the cab.

1247-Q.—What are the instructions in regards to the independent brake valve when handling long freight trains in road or switching service?

A.—The independent brake valve should be operated with care, to prevent damage to cars and lading.

1248-Q.—What causes the damage referred to?

A.—It is caused by slack running in or out too fast.

1249-Q.—What should be done in case of an emergency arising while the independent brake is applied?

A.—Apply the automatic brake instantly.

1250-Q.—When at all practical, what should be done as soon as the train comes to a stop, especially in passenger service?

A.—Release the automatic brakes as soon as the train comes to a stop and hold the train with an independent application.

1251-Q.—What precaution must be taken with the B unit when operating with the Hostler's brake valve or hauling the units Dead in a train?

A.—With the electro-pneumatic brake, the straight air pipe must have an atmospheric opening, either through the 21-B magnet portion (cut-out cock open) or the end cut-out cocks.

1252-Q.—When would this rule apply?

A.—Any time the hose is not connected and open through into the A unit pipe.

ELECTRICAL SECTION

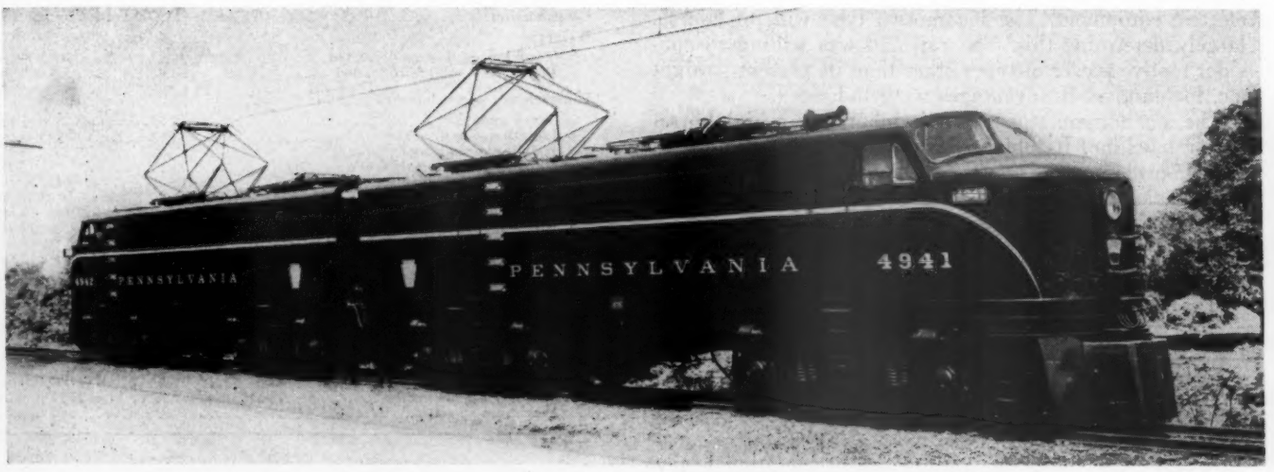


Fig. 1—Two units operating in multiple as a 5,000-hp. locomotive

Series A. C. Electric Locomotives With Dynamic Braking*

New Pennsylvania locomotives built by General Electric which meet specifications of simplicity and low first cost are now in regular service

By F. D. Gowans†
B. A. Widell†
A. Bredenberg†

RAPIDLY increasing use of diesel-electric locomotives in the past few years has caused much speculation on the future of railroad electrification. Proponents of the diesel-electric point to its lower first cost, while the electric locomotive enthusiast claims lower maintenance and operating costs. The final answer will be an economic one, dependent upon such things as future electric power developments and new sources of fuel oil supplies.

The important fact is that the railroads have accepted the electric drive as the best and most efficient means yet developed for propelling railroad vehicles. Now it is of prime importance that the components of this drive,—whether for straight electric or diesel-electric locomotives,—and the vehicle which it propels be continually improved. The builder should make every effort to include in his new designs improvements in materials and processes, together with any other factors, that will contribute to longer life, higher availability and lower overall cost.

*Abstract of a paper presented at the Mid-Winter Meeting of the American Institute of Electrical Engineers, held in New York, January 21-25, 1952.

† Locomotive and Car Equipment Department, General Electric Company, Erie, Pa.

What Type Locomotive?

One important factor in the success of a locomotive is the type and arrangement of the mechanical parts. Past designs with many axles (some idle), complicated trucks and crowded cabs are good examples of high first cost, difficult manufacture and expensive maintenance.

Freight traffic on the road's electrified lines was studied over a period of years to determine what size unit would give the best utilization. A four-axle, locomotive unit capable of operating in one, two, three or four-unit combinations was chosen. Experience with existing electric freight locomotives showed that tonnage ratings should be based on average tractive force over the ruling grades equal to 16 per cent adhesion. At the 60,000-lb. axle loading limit specified by the railroad, this amounted to

a one-hour tractive force rating of 9,600 lb. per axle, or 38,400 lb. per unit. Table I shows how such units could handle the railroad's freight traffic through a typical industrial cycle. This size is also most desirable because of its simple mechanical construction and the additional availability it offers over larger units.

Selection of Electric Equipment

Equally important is the type and arrangement of the electric equipment. The locomotive type will, of course, largely determine this. The railroad was willing to consider motive power of types other than its present straight a.c. locomotive, if advantages were indicated.

The a.c. commutator motor is inherently a high-horsepower machine. Its chief advantage lies in its ability to take 25-cycle power from the trolley without intermediate

TABLE I—UTILIZATION OF LOCOMOTIVES

Number Units	Per cent of Freight Traffic		
	Peak	Normal	Depression
1	13	34	64
2	60	63	36
3	22	3	0
4	5	0	0

conversion equipment. For this reason, locomotive ratings are based entirely on the traction motors. With over-voltage transformer taps, motors can be operated at extremely high short-time ratings for accelerating heavy trains and ascending grades. The relative simplicity of the equipment permits good arrangement, making ample space available for maintenance and inspection. The additional weight and cost of the a.c. motor are offset by the conversion equipment necessary if d.c. motors are used.

Advantages were decidedly in favor of continuing with the straight a.c. type locomotive. This has been the basic motive power on the Pennsylvania's electrified lines since 1931, and has given commendable service. Railroad schedules, operating practices and shop facilities have been built up around it. Twenty years' experience with this plant has demonstrated that simplicity of mechanical construction and of electric circuits is the key to low maintenance and reliable operation.

Characteristics

Table II gives weights, dimensions and ratings of a single unit. Units may be coupled for multiple operation

TABLE II—LOCOMOTIVE UNIT DATA

Classification	B-B-240/240—4GEA632—11,000 volts, 25 cycle a.c
Weight:	
Total locomotive, fully loaded	240,000 lb.
Per driving axle, fully loaded	60,000 lb
Dimensions (Approximate):	
Track gage	56½ in.
Length inside knuckles	54 ft. 3 in.
Height over cab roof	14 ft.
Height, trolley locked down	15 ft.
Width over cab sheets	10 ft. ⅛ in.
Width overall	10 ft. 7 in.
Total wheel base	39 ft. 10 in.
Rigid wheel base	11 ft.
Length between centerplates	28 ft. 10 in.
Wheel diameter	48 in.
Coupler height	34 in.
Clearance, motor gear case to rail	4⅝ in.
Minimum curve	275 ft. radius—21 deg.
Ratings:	
Tractive force at 25 per cent adhesion	60,000 lb.
Tractive force, continuous rating	35,400 lb.
Tractive force, one-hour-rating	38,400 lb.
Speed, one-hour rating	25.5 m.p.h.
Maximum speed	65 m.p.h.

from either end, with as many as four units operating together.

Characteristics for one traction motor are shown in Fig. 2. These may be used in combinations of 4, 8, 12, or 16, with 1, 2, 3 or 4 units.

In recent years rheostatic braking, now commonly used on diesel-electric locomotives, has established its worth in dollars and cents. This usefulness, especially in freight service, has now resulted in its application on a straight a.c. locomotive for the first time in the United States.. Braking characteristic curves for the two-unit locomotive are shown in Fig. 3. The a.c. commutator motors are well adapted for this use, rating 750 hp. each, during braking within the limits of maximum excitation and commutation.

Mechanical Design

The mechanical design—with a streamlined, single-end cab carried on two, two-axle, swing-bolster trucks—is

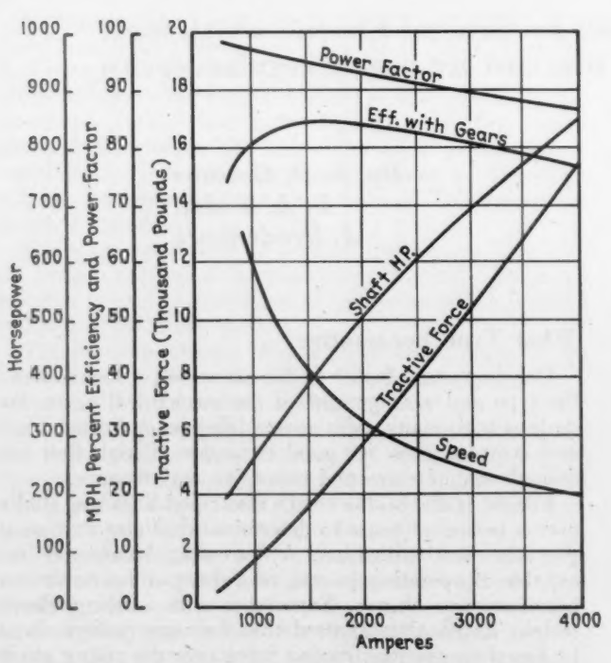


Fig. 2—Motor characteristics on 230 volts with 83/21 gearing and 48-in. wheels

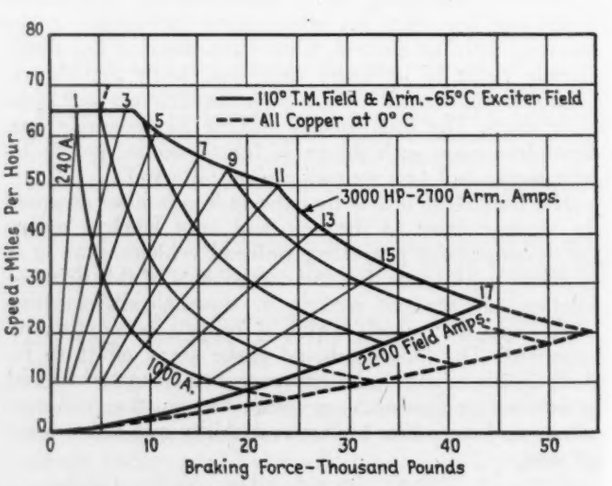


Fig. 3—Speed-braking force curves for one four-motor locomotive unit with 83/21 gearing and 48-in. wheels

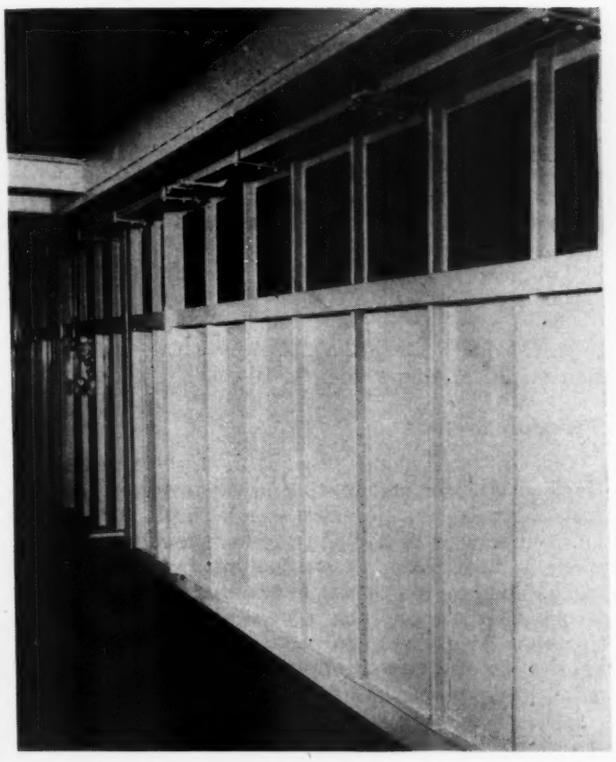


Fig. 4—Side sheet construction used to form supporting truss for platform

quite different from earlier a.c. freight locomotives. Except for the pantographs on the roof, this locomotive resembles the conventional diesel-electric "A" unit. Collision framing at each end is of sturdy construction. The streamlined nose affords additional protection and excellent visibility for the engine crew.

Doors are located at each end of the unit, on each side of the operating compartment, and on the right side of the apparatus compartment toward the rear. Framed grilles in each side of the apparatus compartment as high as possible from the ground, permit entrance of clean cooling air for the traction motors, controls and transformer.

The entire cab and platform structure is fabricated from steel sheets, plates and shapes; and is designed for subassembly of parts and equipment groups. Arrangement of apparatus in the cab provides maintenance aisles on each side, with doors into the operating compartment at the front, and access to the rear end door. Hatch covers over all equipment permit complete accessibility from the roof.

Locomotive platforms were formerly designed to carry the entire equipment load and withstand the buff without undue deflection. The cab side sheets and roof were part of the platform load. No doubt they added some stiffness to the structure, although this was not considered in the calculations. By designing the side sheets to prevent buckling, they can be used as side trusses to carry the entire load. The consequent reduction of material in the platform amounts to approximately 40 per cent, as compared with a 5 per cent increase in side sheet material. This construction (Fig. 4) results in considerable weight and cost reduction, and has been adopted for the new locomotive design.

Conventional two-axle, swing-bolster trucks are used (Fig. 5). These have cast-steel frames, drop-center equalizers, and clasp brakes. The spring rigging is generally similar to that used on Pennsylvania passenger cars. Coiled springs support the truck frame on the equalizers, and an arrangement of coil and elliptic springs supports the bolster on the spring plank.

Location of Apparatus

Two factors largely determine locomotive inspection and maintenance costs: reliability of the equipment and its accessibility in the locomotive. Although the latter may be secondary, neither can be ignored if the locomotive is to be considered satisfactory. In designing these units, prime consideration was given to the location of apparatus. This was planned first and, with few exceptions, the mechanical design was made to suit.

Fig. 6 shows that the traction-motor control groups and blowers are located directly over the trucks. Bus bar and cable runs are thereby kept to a minimum, and blowers discharge directly downward into the motors. Conditions at the rear end are ideal, but at the front end the control group and one blower had to be offset to accommodate the operating compartment. Both motor control groups receive power from the transformer and its control group which, together with the auxiliary equipment, is located centrally. Motor controls are accessible through doors along each side aisle. A crosswise maintenance aisle for the transformer group extends from one side aisle to the other.

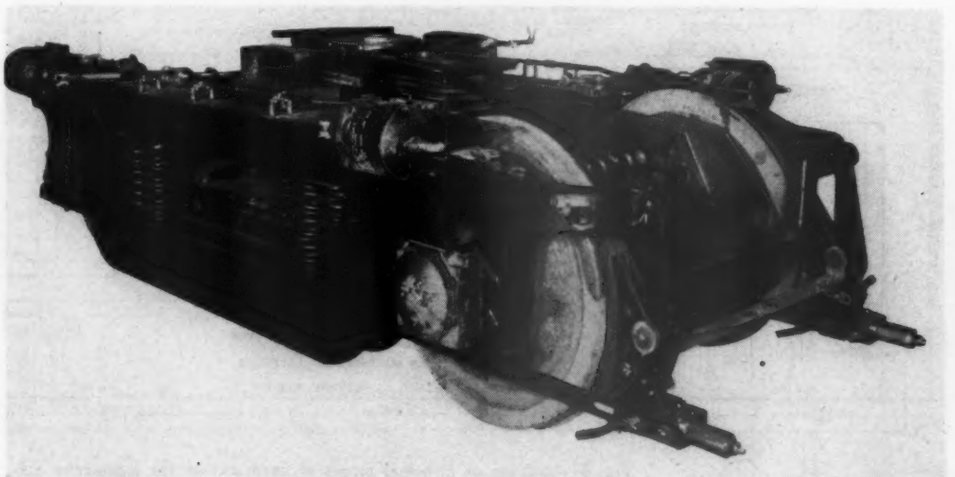


Fig. 5—Two-axle, swivel truck of conventional design used on this locomotive

The location of the transformer high-voltage bushing and Thyrite resistance lightning arrester on the roof is unusual. The transformer tank is the full height of the apparatus cab, allowing the bushing to protrude through a cutout in the hatch cover directly under the front pantograph. An insulated bus on the roof connects both pantographs, the lightning arrester and the transformer. It also serves as the terminal for the ground switch. This arrangement eliminates all 11,000-volt cable, cable preparation and conduit, together with the shields and barriers necessary for the protection of workmen inside the apparatus cab from contact with this voltage.

The two pantographs on the roof of each unit are accessible from inside the cab by means of a ladder and hinged door in the hatch cover. This door is mechanically interlocked with the pantograph grounding switches to prevent access to the roof when the pantographs are ungrounded.

Auxiliary Equipment

Considerable improvement has been made in auxiliary equipment. For instance, the use of axial-flow blowers has contributed to better arrangement and accessibility of equipment because they occupy about half the space of centrifugal blowers of the same rating. The blowers incorporate an air-cleaning feature which removes about 60 per cent of the dirt, water and snow from the air furnished to the electric equipment. Since they are driven by three-phase induction motors, the expense of brushes, commutator maintenance and frequent inspection is eliminated. Because of their exceptionally good characteristics for ventilating this type of equipment, these blowers have been used throughout the locomotive.

An auxiliary motor-generator set provides three-phase power for the blowers and d.c. power for control and battery charging. It consists of a two-speed, 25-cycle, single-phase induction motor driving a 125-cycle, 3-phase alternator and a 37.5-volt d.c. generator. The motor is arranged for pole changing to give half (750 r.p.m.), and full (1,500 r.p.m.) speed. This gives half- and full-speed operation of the blowers since they are connected directly across the alternator.

Air brake equipment is 8EL, modified to use the DS-24 automatic and S-40-F independent brake valves. This will permit application of speed control later.

A new feature is the use of the diesel-electric locomotive type air compressor. It is coupled to a 25-cycle, single-phase induction motor and arranged for unloaded starting. It has a capacity of 220 cu. ft. per min. at 725 r.p.m.

Two main air reservoirs, having a combined volume of 50,000 cu. in., are located under the platform.

Traction motor excitation, during rheostatic braking, is provided by a 1,500-r.p.m., 25-cycle, single-phase induction motor, driving a 10-pole, 10-volt d.c. generator.

Traction Motors

The GEA 632 motor (Fig. 7) is a 16-pole, 25-cycle, single-phase, commutator-type, a.c. motor with commutating poles and pole face windings. It is rated 625 hp. continuously at 230 volts. The maximum operating speed is 1,800 r.p.m., corresponding to a speed of 65 m.p.h. on these particular locomotives. The motor is mounted on the axle and a nose support on the truck transom. A cushion gear, pressed on the axle, is driven by the motor pinion. Motors are connected in two parallel groups, each with two motors in series.

It has long been recognized that better performance can be obtained from a straight-electric locomotive traction motor than from a diesel-electric or motor-generator locomotive motor. On a.c. locomotives, this extra performance is obtained by providing overvoltage taps on the transformer. The multi-pole, low-flux per-pole type of single-phase, a.c. motor is ideally suited to transmit this additional power. Although the design is largely predicated on considerations of standstill starting phenomena, it is also the best to withstand applications of overvoltage. The first motors of this general type were placed in service on the Pennsylvania in 1931.

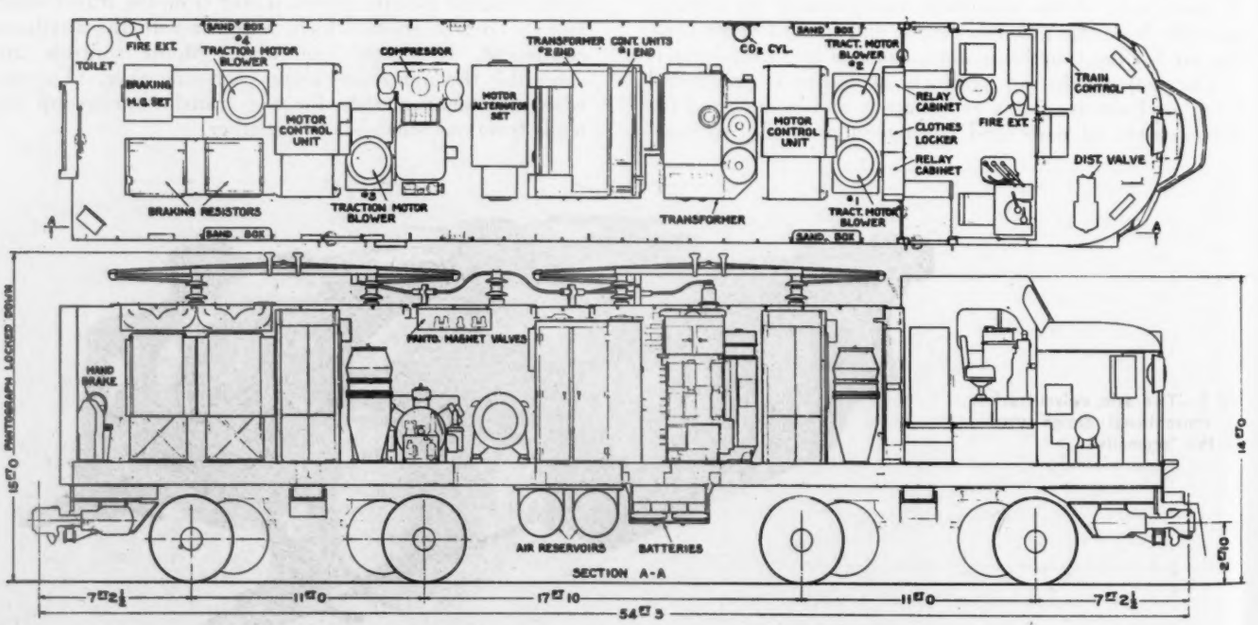


Fig. 6—Location of principal pieces of apparatus in the locomotive cab

The present motor reveals the significant design progress made since 1931. The continuous horsepower per pound increased 44 per cent in the 1934 design, 13 per cent in the 1938 design, and 26 per cent in the 1951 design.

Electrical and Mechanical Differences

Electrical design points differing from former motors of similar type are:

1. A slightly smaller exciting-pole air gap, and a larger commutating-pole air gap.
2. Armature slots that are open instead of partially closed, to permit using pre-insulated coils with their inherent advantages.
3. Solid armature bar in place of the folded bar.
4. More armature slots per pole and shallower slots, to partially offset the additional losses in the solid armature bars at high speeds.

Brush holders are of the one-piece type, light and simple in design. Ample clearances around the brush prevent its binding in the holder as a result of accumulations of dust.

Armature coils are of semi-one-piece, split-throw design with flattened leads for connecting to the commutator risers. Less than half as many back end brazes are required as formerly. The bars have a straight portion at the back end connections of the winding to give additional surface for binding purposes.

A revolving brush-holder yoke permits inspection and replacement of brushes. This is located to line up the brush holders in correct relation to the main poles by a key set accurately with fixtures at the factory.

The cushion gear is similar to those used in the past, with the exception that tube-form synthetic rubber joints replace the flat or spiral steel springs formerly used to dampen the 50-cycle torque impulses.

Insulation

The continuous motor rating is given on the A.I.E.E. basis for Class B insulation—120 deg. C. rise on the armature and 130 deg. C. rise on the field as measured by resistance. Conductor insulation, armature polycoil tapes, and stator winding slot wrappers consist of glass and mica, treated with silicone varnish. Each motor is blown with 4,200 cu. ft. of air per min.

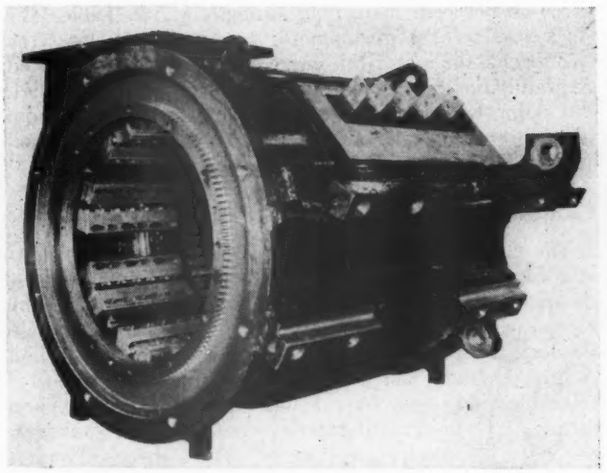


Fig. 8—Traction motor stator, with frame head removed to show brush holders and revolving yoke

Main Field Flux Control

At standstill, and during very low speed operation. circulating currents exist in the armature turns which are short-circuited by the brushes. These currents are induced by the 25-cycle main field flux. At low motor speeds, they cannot be restricted by commutating-pole flux control. In order to hold these currents to a tolerable value, the main field flux must be limited in amplitude. This is accomplished by a combination of autotransformer and inductive shunt which weakens the field to 40 per cent of full strength (FS-3, Table III). As the locomotive speed increases, a "speed voltage" is generated in these short-circuited turns by an out-of-phase component of the commutating-pole flux, often referred to as quadrature compensation. This voltage serves to reduce the circulating currents to the extent that, at three m.p.h., the autotransformer may be cut out. This

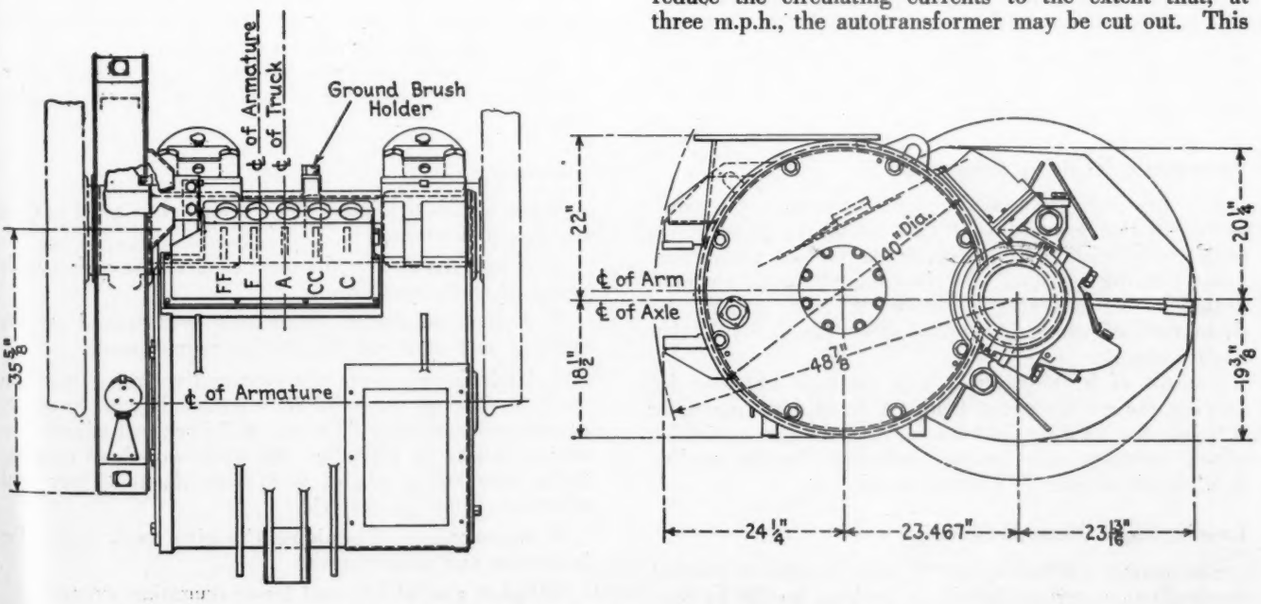


Fig. 7—Outline of traction motor with principal dimensions

gives 76 per cent main field strength (FS-2, Table III). As a result, for a given motor torque (locomotive tractive force), the motor line current is significantly reduced. At 7 m.p.h., the circulating currents have decreased to the point where the main field shunting may be completely removed. Operation then continues in full field (FS-1, Table III), at higher speeds.

Commutating Field Flux Control

The quadrature compensation voltage mentioned above is a function of both motor speed and the magnitude of the quadrature component of commutating pole flux. This component of flux, lagging the motor line current by 90 deg., is produced by shunting the commutating field. A given shunt will restrict circulating currents to a tolerable value only over a limited speed range. Three settings of commutating pole shunting are required to cover the locomotive speed range. The low-speed shunt—a resistive impedance—is connected across the commutating poles from standstill to 26 m.p.h. As already noted, this is not fully effective below 7 m.p.h., and main field shunting must be resorted to (Conn. Nos. 1, 2 and 3, Table III). Above 26 m.p.h., commutation again becomes unacceptable with this shunt. Supplementary resistive-reactor impedances are connected over the intermediate speed range from 26 to 40 m.p.h. (Conn. No. 4, Table III). Additional impedance is connected in the high-speed range above 40 m.p.h. (Conn. No. 5, Table III).

TABLE III—MOTOR CONNECTIONS

Conn. No.	Main Field Connection	Interpole Field Connection	Approximate Speed Range	Contactors Closed*
1	Weak field (FS3)	Low speed (LS)	0 to 3 m.p.h.	F12, F13, F14R, F24R
2	Intermediate field (FS2)	Low speed (LS)	3 to 7 m.p.h.	F11, F12, F14R, F24R
3	Full field (FS1)	Low speed (LS)	7 to 26 m.p.h.	F11, F14R, F24R
4	Full field (FS1)	Intermediate speed (LS)	26 to 40 m.p.h.	F11, F14R, F24R, F15X, F25X
5	Full field (FS1)	High speed (HS)	Above 40 m.p.h.	F11, F14X, F24X, F15X, F25X

* Contactors for No. 1 and No. 2 motors only are listed.

Control Equipment

Multiple-unit, single-end control of the electro-pneumatic type is used. Two spring-raised, air-lowered pantograph trolleys collect current at 11,000 volts from the trolley wire. The main transformer—rated at 2,655 kva., 11,000/762 volts, 25 cycles, single-phase—is Pyranol filled and forced ventilated.

Rheostatic Braking Operation

For braking, the traction-motor armatures are connected in two groups. The two armatures in series in each group operate as d.c. generators across a constant-value braking resistor. All four motor fields are connected in series across a low-voltage, d.c. exciter, the shunt field of which is supplied from the 37.5-volt, d.c. control circuit.

Control of braking effort and speed is obtained by varying the exciter shunt field. This is done manually through the braking handle on the master controller which operates only seven contactors in the exciter field circuit to give 17 braking steps.

Low-Voltage Control Circuits

The master controller has a main handle to control acceleration, a reverse handle, a braking handle to control rheostatic braking, and a selector handle to control the motor-alternator set. Suitable mechanical interlocking prevents improper operation of these handles.

Protection

Circuit and apparatus protection for these locomotives centers in a transformer protective relay for the main transformer, and a ground relay for the traction-motor and auxiliary circuits. These are supplemented by wheel-slip relays for the traction motors and thermal overload devices for the auxiliaries.

The ground relay has a set of "A" contacts which trip when the relay element rotates part way and a set of "B" contacts which operate when the relay travel is complete. In case of a ground on a traction-motor or 25-cycle auxiliary, the "A" contacts open and latch in the tripped position, de-energizing the traction-motor line contactors and auxiliary contactors. With these open, the grounded equipment is cleared and the relay returns to normal position. The "A" contacts may then be reset remotely from the operator's position. After the faulty circuit has been isolated, operation (possibly at reduced capacity) may be continued.

Should the ground be on the transformer side of the various line contactors, as mentioned above, the ground relay will not stop after tripping its "A" contacts, but will continue around and close the "B" contacts, causing the auxiliary relay to operate. This connects the de-sensitizing resistor in series with the ground relay operating coil, causing the latter to return to its original position so that the "A" contacts may be remotely reset. This arrangement permits operation of the locomotive in an emergency with a ground between the main transformer secondary and the line contactors of connected apparatus, with the ground relay having been automatically de-sensitized.

There are two systems of wheel-slip protection for the traction motors. One consists of a power tie connecting the mid-voltage points of both two-motor series circuits. For each circuit there are two motors in series and both are on the same track. Two current-element, wheel-slip relays are located in this power tie.

The second wheel-slip protective system is provided by a.c., d.c. voltage relays, two in each two-motor circuit. They operate on a difference in potential between the two motors in each group. One relay in each group is a warning relay, the other a trip relay.

These systems also provide protection against overspeeding as a result of a slipped pinion on the traction motor.

Summary

These locomotives have been designed to meet certain basic requirements:

1. A unit size to give the most efficient use over a wide range of traffic conditions.

2. A type of electric equipment well proved on the railroad and most suitable for its requirements.

3. High horsepower: the locomotive rates continuously at 625 hp. per axle, 26.5 m.p.h. It will, however, accelerate trains up to 33 m.p.h. at 25 per cent adhesion—corresponding to 1,300 hp. per axle—and haul tonnage trains over ruling grades at 41.5 m.p.h. at 16 per cent adhesion, 1,060 hp. per axle.

4. Arrangement of equipment to give ready access for inspection and maintenance.

5. Higher availability and lower operating expanse.

6. Lower first cost.

DIESEL-ELECTRICS—How to Keep 'Em Rolling

6 Insulation—Its Purpose and Its Requirements*

If insulation is given the care it deserves, the maintainer can avoid a lot of grief and hard work

Why Insulation?

Electricity, like many people, follows the path of least resistance. It is always looking for short cuts to get out of doing work. The material we use to keep it on the job is called insulation. It confines the electricity to a useful path — usually through copper wires. Non-metallic materials like glass, mica, porcelain, wood shellac, and varnish are some of the better insulators. Even dry air is good for this job. Electricity has a tough time getting through or across these materials.

If the conductors of a machine could be bundled up in plenty of insulation, you might think the machine would last forever. But the problem is not that simple. "The more the better" isn't always a good recipe to use with insulation. Remember, heat is generated in an electric machine when it is working. And good electric insulators are also good heat insulators. This means that insulation acts like a blanket to keep the heat in the machine. While not enough insulation will wreck a machine, by allowing electricity to escape, too much insulation will also hurt it by making it overheat. So, to let the heat out, just enough insulation is used to keep the current in the wires.

Another thing, there is only so much space in a ma-

* This is the sixth of a series of articles on maintenance of diesel-electrical equipment. This article is written by J. W. Teker and J. R. Schrecongost, both of the Locomotive and Car Equipment Department, General Electric Company, Erie, Pa.

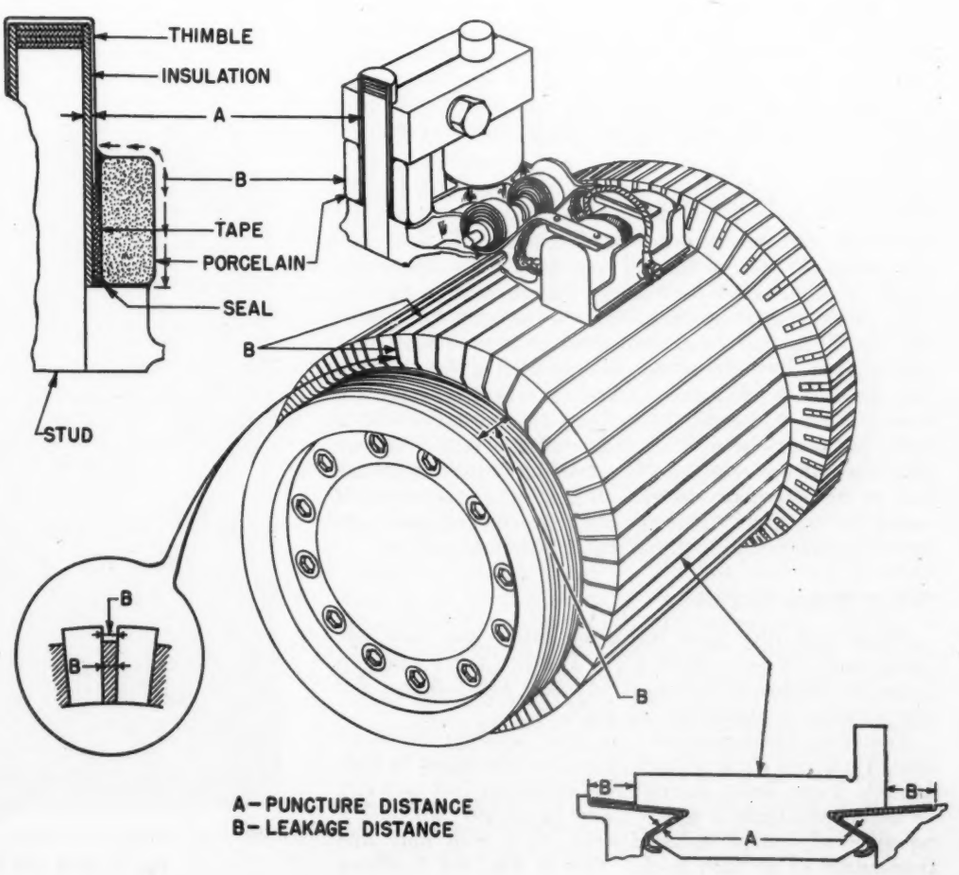


Fig. 1—Details of brush-holder and commutator insulation

Fig. 2—Accumulation of oil and dirt on generator field coils

chine. This has to be divided between copper, iron and insulation. Since it is electricity that transmits the power to pull trains, we try to get all the space we can for copper and iron. This is another reason for not using any more insulation than necessary.

Although it doesn't take much insulation to hold electricity in, what there is must be o.k. The maintainer's job is to keep this insulation in good condition so it can do its work well. Now, let's look at the job insulation has and see some of the things that may happen to it.

Electricity's Traffic Cop

Motors and generators depend upon the flow of current through their field and armature coils where the work is done. Insulation keeps this current in the circuits leading to these coils. It also separates the turns of the coils so that the current must go around each turn. This makes the current do its magnetizing job. When the insulation fails, the current short-cuts across the turns. Then it doesn't do its job, and we have what is called a "short circuit". If the insulation fails in a way that lets current escape to the machine parts which are not in the regular electric circuit, we have what is called a "ground." This means that current gets into parts connecting with the earth or ground.

What Makes It Fail?

"How and why does insulation fail", you may ask, "and what can I do about it?" The two more common forms of insulation failure are puncture and leakage, and sometimes a combination of both.

Puncture: Insulation has very good resistance to puncture. However, if the voltage (electrical pressure) is high enough, it can break through the insulation just as water or steam can burst a pipe. Good insulation will hold a pressure of several hundred volts on a wall only one thousandth of an inch thick. This is fine, for it allows most of the circuits inside a machine to be completely enclosed by insulation thick enough to hold the electricity in, but thin enough to let the heat out. What's more, today's insulating materials keep their puncture strength for years of regular duty. Then why worry about insulation at all?

One reason is the danger of mechanical damage. Because insulating materials are mechanically weak, the thin layers used are easily damaged. Careless handling of tools, or parts, may cut or puncture the insulation. Loose coils on poles shake and wear their insulation. Relaxed armature bands let coils buzz and wear through. Vibration from bad gearing or a rough engine seeks out and punishes any insulation that is free to chafe. Rough cleaning treatment, or prolonged soaking in strong solutions may be harmful, both mechanically and electrically. Dirty or loose terminal connections get hot and char the insulation on the conductor. Using flame to thaw out steam or air pipes that are near conduits carrying electric wiring may burn cable insulation. From these examples, you can see that damage is a greater enemy of insulation than is puncture by any operating voltage. So if you keep damage off the job, the insulation built into the machine will keep electricity on the job.

Leakage: While most of the conductors in a machine are completely enclosed with insulation, there are certain parts that must be left exposed. An example is the commutator surface and brushes (Fig. 1), which must make sliding electric contact with each other. How to keep electricity from escaping at these exposed places is a problem especially worth understanding. At such points, the current is no longer walled in. Hence, it can leak or "creep" away through any conducting material that

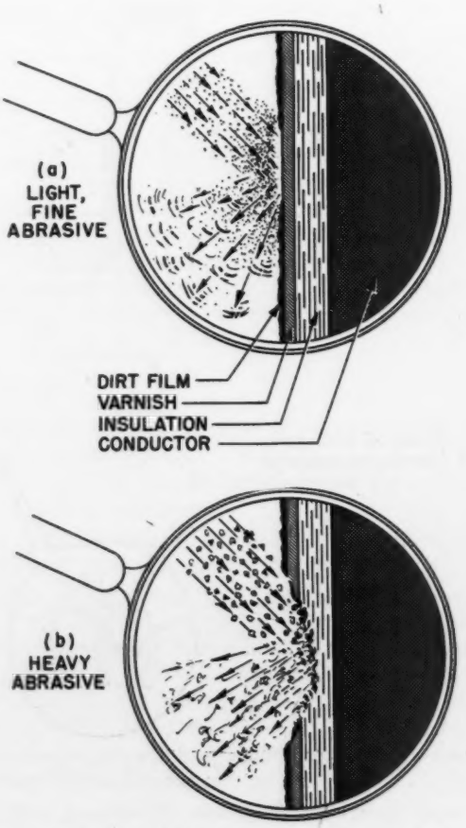


Fig. 3—Good and bad air-blasting practice

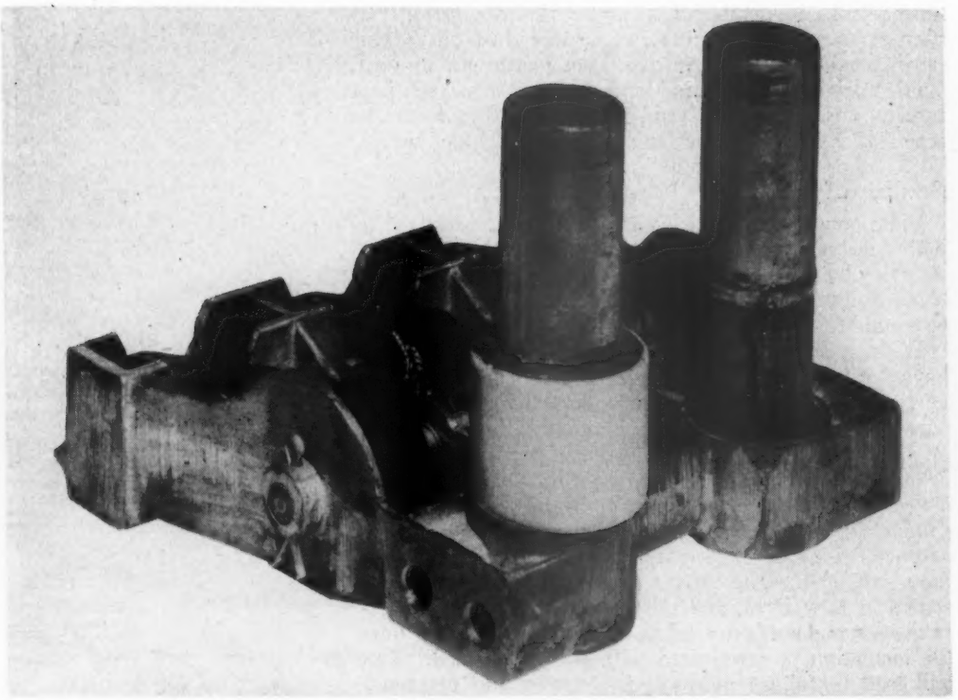


Fig. 4—Tracking of brush-holder insulation due to leakage under porcelain sleeve

comes close enough to provide an escape path. To guard against this leakage, the puncture insulation is extended over the nearest part, offering such a path. Now the current must either jump through a long air space or manage somehow to creep over this extended insulation surface in order to escape. But air is a good insulator, so if you keep conducting material off the extended insulation (leakage) surface, the problem is solved. But, locomotive operation takes insulation through all kinds of conditions, summer and winter, which affect this maintenance. job.

Fig. 5—Failure of commutator string band on a generator as a result of leakage

Dust Is Your Enemy

Railroad dust is a good electrical conductor because it contains lots of particles worn from wheels and brake shoes, as well as carbon in several forms. As these conducting specks settle on the leakage surface, the air spaces between them get smaller and smaller. Finally, current begins to escape by creeping from speck to speck. You can see how this happens if you think of using stepping stones to cross a stream of water. Even a wide stream can be crossed if you throw in enough stones. Of course, such a path is not like a solid bridge. Only a little current can escape across it at first. You can sometimes see the escape path by the twinkling glow of the tiny sparks.

Maybe such a small thing doesn't seem worth worrying about, but be careful! Electric sparks are very hot—like arc welding or lightning on a small scale. If not checked, these sparks will burn the insulation surface and form a carbonized path. Then the current doesn't have to jump from speck to speck. It begins to flow steadily over the charred surface. As it flows it forms a hotter and bigger path. If a ground relay doesn't trip or a cleaning job come to the rescue, the entire power of the machine will eventually blow through to a failure.

The longer the leakage distance, the more dirt and voltage it takes to span it. But, of course, a machine can't be all leakage distance. Many years of maintenance experience have shown just about the right balance of space between leakage distance and the other working parts of a motor or generator. When dirt conditions are worse than average, these surfaces must be cleaned oftener to keep them effective. Smooth, glossy surfaces collect less dirt and are easier to clean. To keep leakage surfaces good: First, keep as much dirt as possible out of the machines. Maintaining engine room air filters in good condition helps reduce the dirt in the ventilating air.

Next, do a thorough job of getting rid of what dirt

does get in. Remember the leakage surfaces during regular cleaning when you blow the dry dust out of the machines. Blow with a purpose, not just to stir up dust. Engine-driven generators and exciters can be kept turning during blowing. In this way, all surfaces can be reached, and the machine fans will help expel the dust.

Beware of Moisture

Solid conducting particles are not all that form escape paths across insulation. Water, with conducting material dissolved in it, will readily carry current. An illustration of this is the way current flows through the acid-water mixture in a storage battery.

When a leakage surface gets wet, the current doesn't have to try to jump through the air spaces between particles. It can get across through the water. In fact, current can then bridge gaps impossible for it to cross on dry insulation. Trouble begins if the film of water is carrying current when it starts to dry up. This drying may be by natural evaporation or by heat, if the path is conducting enough current. The surface does not dry all at once. Tiny dry spaces form here and there between the wet patches. The current easily jumps these little dry spaces as they form, and the sparks char the insulation. If the water doesn't dry off faster than these sparks burn the insulation, a carbonized path will be formed. This will lead to failure unless it is detected and corrected.

Moisture has a way of soaking into tiny spaces that dry dust alone could not penetrate. It seeks out pinholes and cracks to start leakage paths in insulation that would be perfectly safe if dry. That's why you should be cautious about applying power or making high-potential tests on wet machines. The insulation should be dried out first. This can sometimes be a problem.

When a cold machine is moved into a warm shop or enginehouse, it breaks into a sweat. Moisture froms on it just as drops of water collect on the outside of a glass of ice water on a hot day. Or the machine may have run through a severe snow or rain storm and soaked the insulation without being hot enough to dry the moisture off as it came through. If left in the warm enginehouse, the machine may dry out in time. Or a blast of hot air can be blown through it to speed up the drying. A generator can be short circuited with a temporary connection and then driven at low excitation to get it hot. The short circuit will allow a high heating current and, at the same time, keep the voltage low.

Another Bad Actor

Dry dust and moisture are not the only enemies of insulation. Diesel engines and air compressors like to splash and blow around in oil. They have a generous way of sharing it with everything in the engine room—even the insulation of the electric machines. While clean oil is a good insulator, it is also a good dirt collector. Oil fumes, or even solid droplets, in the engine room air deposit a thin film of oil on insulation. This makes the surface sticky, and when dirt particles fall on it, no amount of blowing can get them off. The deposit gets thicker and thicker. It builds up against field coils, in corners and over to terminals (Fig. 2), until a leakage path is formed. Then it settles down to glow and burn, just as in any other leakage failure. Like water, oil has a way of finding and seeping into pin holes and cracks in the insulation.

Such mucky dirt must be washed away with a solvent. The perfect solvent evaporates rapidly, without leaving a conducting residue. It doesn't harm the insulation,

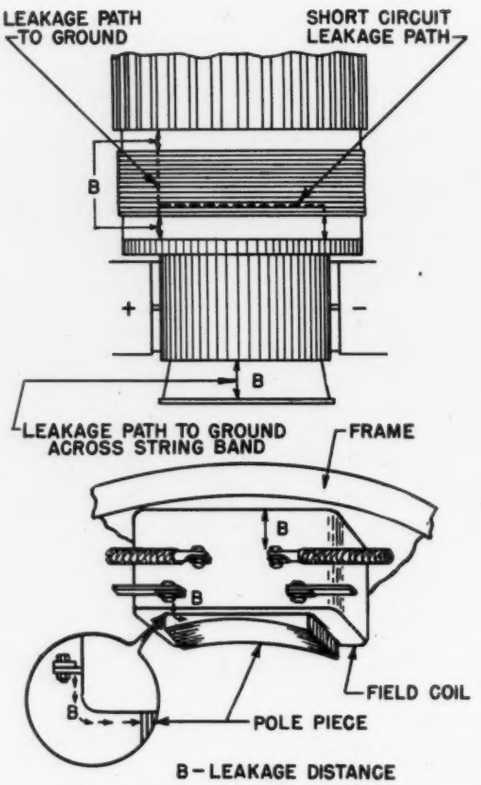


Fig. 6—Typical leakage surfaces on armatures and fields

will not burn or explode, and is not poisonous. No one has yet found this perfect solvent, but a number of good ones are in use.

Carbon tetrachloride comes close to filling the bill, except that it must be used with care. Precautions must be taken to guard against personal injury, especially from breathing the fumes. Perchlorethylene is not as poisonous, but any of these good cleaners must be used with caution—just like fire or electricity. Follow carefully the instructions worked out by your Safety Committee experts for your own good. Do not use more solvent than necessary, and provide good drainage so that it doesn't float the dirt to a place where it will do more harm. Where possible, it may be a good bet to wipe with the solution instead of washing or spraying.

Locomotive "Traffic Film"

Our last trouble maker—and probably the most difficult to remove—is a smoke-like deposit of fine carbon. It does not blow or wash off. It is like the "traffic film" on your car. If you squirt the body with a hose, it looks clean while it is wet, but as soon as it dries, it is as dull and grimy as ever. The only way to get the stuff off is by scrubbing. As you know by experience, you've got to lay hands on it. This is all right as long as you can get at these grimy surfaces. Some, however, are hard to reach, such as the pockets between coils at the end of the armature slots, or behind commutator ears or risers. Here is a good place to use an abrasive blast. Like any powerful tool, it must be handled with caution and full understanding of what it does. Otherwise, you can do more harm than good with it. Heavy, abrasive particles driven by a powerful air jet will not stop after removing the dirt. They will cut through the protective varnish coat and rip the insulation to shreds (Fig.

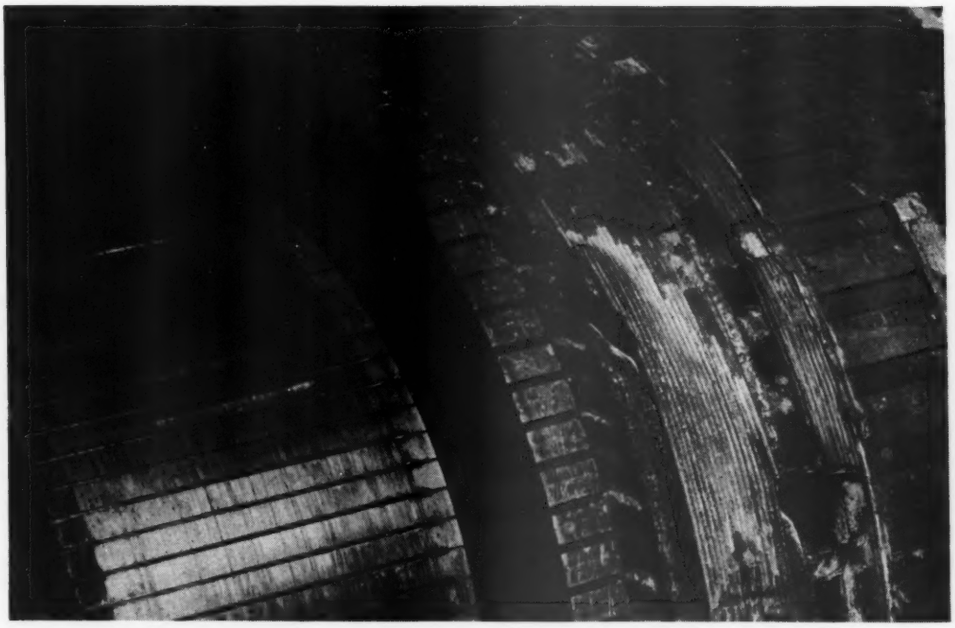


Fig. 7 — Generator armature bands burned by short circuit currents

3b). Heavy, soft, sponge-like pellets driven at high speed will pound a surface. Maybe they won't cut, but they will loosen the bond between the layers of insulation.

Because this dirt forms only in a fine layer, a very light flour-like abrasive is all that is needed (Fig. 3a). Driven at moderate speed with usual shop air pressure (90-100 lb.), it will give a cleaning heat that cuts fast enough to control without doing any harm. Don't make the mistake of blowing a solid stream of abrasive. Cut it down so only a fine, barely visible dust shows. Let the air do most of the work. Above all, study and understand what you are using and what it is doing. Don't think only of the present cleaning job. Remember what effect your present action may have on the future operation of the machine—you don't want to cause a rebuilding job. Protect yourself too; be sure to wear a respirator.

You Can't Cover Up

There is a strong temptation to paint insulation instead of cleaning it. This may make a nice looking job, but it doesn't fool the electricity. Don't think you can get away with it. Painting dirty insulation is the worst possible thing you can do. The layer of conducting dirt is still there, although covered up with shiny, new paint. The current leaks through it just the same, only now with the paint over it no one can get at it to clean it off. The backshop will find you out when they strip the machine down to rebuild it after it blows up.

If there isn't time for a good cleaning job, it is much better to let the machine go without painting. Then you have a chance of improving it next time. Be wary of insulation that looks dirty, but measures good. Don't paint it. Remember that wiping only a small gap across an otherwise dirty leakage surface is enough to give a good megger reading. Such a small gap will fill with dirt much faster than if the entire leakage surface were properly cleaned.

Points to Watch

A machine has many leakage surfaces all of which are important to its proper operation. Let's look at some that you will usually be working with. One is the leakage surface from the machine terminals along the cables to the point where they are cleated. Another is from brush holder terminals along the cables or connection rings to the point where these are cleated to the frame.

The brush holder itself is insulated from the clamp or support that holds it to the machine frame, as detailed in Fig. 1. In this typical case it is done by an insulating tube over the brush holder stud. Note that the puncture thickness of this tube is small as compared with the long leakage distance from the clamp to the brush holder. A metal thimble is slipped over this tube to protect the clamped portion, and a porcelain sleeve is used to protect the exposed portion. Porcelain is used because it has a hard, smooth, easily cleaned surface. The space between the tube and the porcelain must be well sealed to keep moisture out. Sometimes, to get a tight fit, the tube is wrapped with a tape and then the porcelain is pushed over it. If this joint is not thoroughly filled with varnish or if the porcelain is broken, the tape will soak up water like a wick and form a leakage path on the surface of the insulating tube (Fig. 4).

The string band over the commutator cone protects the mica and prevents it from flaking off. Since this is a leakage surface, the string should be tight, be filled with varnish, and have a smooth surface finish. It the band is loose, dirt will collect under it. Then a leakage path will be formed, even though the outside surface looks good (Fig. 5).

Did you ever think of the side mica in a commutator as a leakage distance between segments? Fig. 1 shows it is, and that is why it is so much thicker than required for the puncture voltage. Keep this surface clean.

Don't forget the steel bands on the armature—especially at the commutator end. The current tried to leak along the path shown in Fig. 6, from the riser at one brush holder position across the armature surfect to the band, then through the band and back across the armature surface to the riser at the next brush holder position. If this happens, the short-circuit current can burn the band off (Fig. 7). This will wreck the armature so that it may slide the wheels. Another path to ground is from the commutator riser across the armature surface

to the band, and from the band across the short distance to the core.

Not all leakage surfaces are on the armature. Field coils have leakage distance from the terminals across the insulation to the pole piece or the frame (Fig. 6). So it goes, from one part of the machine to another, and all these points are important to watch.

Forestalling Trouble

Leakage and puncture are the long and short of insulation. Don't get them mixed up. You will have a lot more to do with leakage than with puncture. Remember that no matter how thick and strong the insulation is, it fails if there is a leakage patch across it. A strong wall means nothing when you put a ladder against it. Any conducting material is all the ladder electricity needs. Keeping dirt off the job is a fine way to keep your machines on the job. If you think of what insulation is, and what it is supposed to do, you will be able to handle it intelligently. The result will be less work and trouble for you in the long run, and more service from the equipment on the road.

Diesel Load Tester On the Southern Pacific

The Southern Pacific has installed water-rheostat diesel-load-test equipment at the Sacramento, Calif., shops which is neat in appearance, convenient and effective in use and well guarded to assure against accidental electric shock to workmen. The tester is located just outside of former pit No. 1 in a steam locomotive repair shop building, one end of which has been converted for handling diesel engine repairs. The safety feature mentioned consists of a wood frame and steel wire mesh fence, 6 ft. high, extending around the tester, as illustrated.

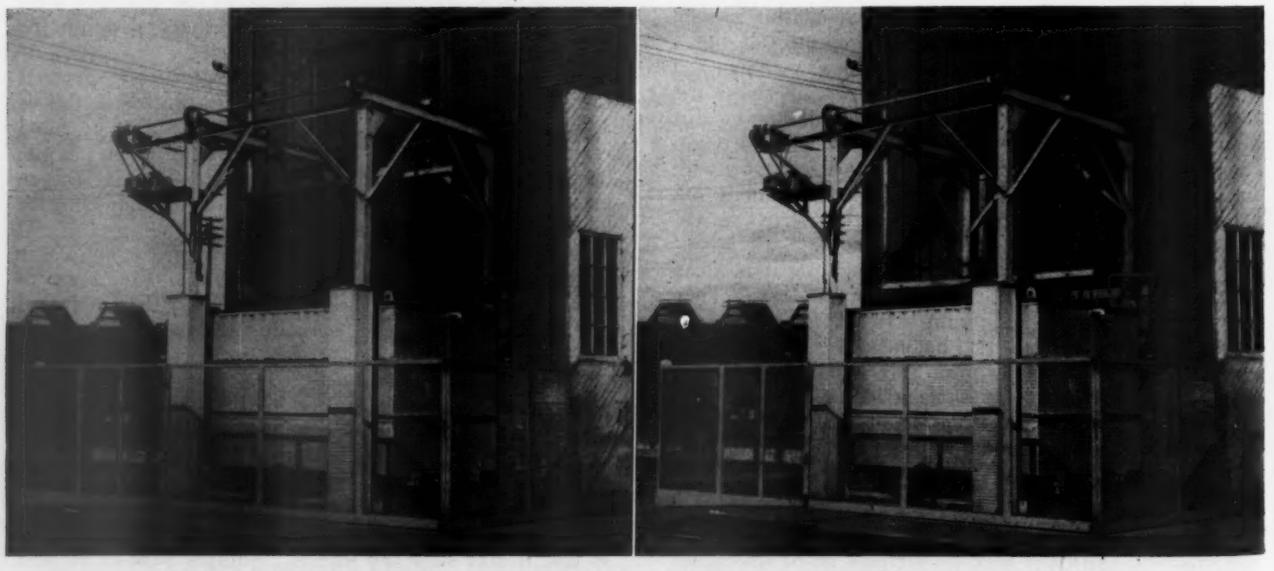
The rheostat consists of a steel tank, 12 ft. long, by 8 ft. wide, by 7 ft. high, made of ¼-in. plate, reinforced with 3½-in. angles and mounted on double rail sections which in turn are supported by 8 high-compression (10,000-lb.) outdoor insulators, resting on a heavy channel-iron base. These insulators, 7½ in. high by 4¼ in. in diameter are equally spaced under the tank and separated from the supporting rail sections and base channels by ⅛-in. thick sheet lead pads, top and bottom. The tank itself is thus thoroughly insulated from the ground.

The steel structure, built around the tank and extending above it, as illustrated, consists of 6-in. angles and 7-in. top channels, suitably stiffened with diagonal braces and provided with motor-driven equipment for raising or lowering the counterbalanced heavy steel positive plates which are immersed in the tank as necessary to meet varying load requirements for the diesel-electric power set being tested. There are three of these steel positive plates, made of ⅜-in. material, 6 ft. wide and of varying lengths, the center one being 6 ft. 8 in. long, and the two outside ones 6 ft. 3 in. and 5 ft. 9 in. long respectively.

The lower ends of the positive plates are tapered the same as corresponding small negative plates 15 in. high, suitably positioned and welded in the bottom of the tank. The positive plates are spaced 3 ft. 4 in. apart and rigidly secured at the top to two 4-in. angles which are 12 ft. 8 in. long, or long enough to extend over the tank ends and support the positive plates a fixed distance from the bottom negative plates when in the extreme lower position. In this position, the 4-in. angles are insulated from the tank ends by 3-in. square creosoted wood blocks.

The two positive-plate supporting chains extend over four pulleys and down to counterweights which operate vertically in the rectangular housings shown close to the guard fence. The two outer pulleys are mounted on a single shaft with 5-ft. extension at one end for double V-belt and worm gear drive from a 3-hp. synchronous electric motor shown in the illustration.

This water rheostat is used for load testing the diesel engines and generators in all types of diesel locomotives. The load is regulated by the depth of the positive plates in the negative tank. A salt solution of from 3 to 20 lb. of salt to a tank of water is used, the amount of salt depending on the size of the engine and being less for the larger engines. At present, the rheostat is used for loads up to 2,000 hp. with voltages up to 1,000.



Water rheostat at S. P. shops, Sacramento, Cal. Positive plates in raised position (left) and lowered (right)

CONSULTING DEPARTMENT

Cleaning and Testing of Locomotive Electrical Equipment*

Questions and Answers

Q.—How can radiator cooling fan alternating current motors be tested to anticipate failure? What causes failure of these motors?

A.—There is a divided committee experience on this matter and opinions are listed in order below:

1.—Failure of these motors is caused most often by their being reversed suddenly. This occurs because in the sequence of operation of the motors, first one picks up, or starts, and in pulling air through a radiator box, which is common to all fans, the other fans will start to turn backwards. Then, when the second fan is required for cooling, it is energized and suddenly reverses.

2.—The type of alternating current motors generally applied to radiator cooling fan service is comparable to that used in industrial application. Owing to the nature of the service, it is debatable as to whether better types of insulation, major and minor, should not be used in such service. The major deficiency in insulation of these motors, which results in failures, other than those originating from improper phase operation, can no doubt be indicated by the application of the surge test principle. We are anxious to learn to what extent this principle of test has been applied to induction motors in locomotive service. Other than tests of this nature, and dielectric absorption tests with Megger testers, we know of no way of obtaining a measure of anticipated insulation life.

3.—Motors are tested with an ammeter to check current draw. We have had a considerable number of cooling fan alternating motors fail on our railroad, and the majority of these failures have been traced back to single phasing. In a majority of the cases, the trouble was found in the plug receptacle; either a poor contact or a loose connection. Loose connections on the a.c. contactors themselves may also cause trouble.

4.—We are not acquainted with a method of testing radiator cooling fan motors to anticipate failure. A number of failures of these motors, which occured during winter operation were apparently caused by snow and ice collecting and freezing around the fans when they were not operating. This resuted in an overloaded condition, and subsequent failure when the fan was brought into operation. On these particular E.M.D. units no overload protection has been applied to the radiator cooling fan motors by the builder. We have requested that overload protection be applied to these motors on new units being delivered.

5.—The cooling fan alternating current motors can be checked with respect to their resistance to ground and for normal rotation. These motors should also be visually examined for any evidence of heating around bearing housings. Failures of radiator cooling fan a.c. motors are very unusual.

6.—Cooling fan alternating motors can be tested to anticipate failure the same as any other alternating motor; namely, by testing between phases, and making

insulation tests to ground. It is our belief that most a.c. cooling fan motor failures occur from short circuits between phases, due to breakdown of insulation. There have been some failures due to motors becoming single-phased from failure of one of the contacts on the contactor.

7.—Test frequently for grounds and loose connections; also give the motor contactors special attention and maintenance to see that all three-phase contact fingers close. Failure of the a.c. current fan motors is caused by locked bearings, the rotor not turning, and single phasing caused by poor operation of contactor fingers.

* Material presented by the Diesel Electrical Committee at the annual meeting of the Locomotive Maintenance Officers Association held in Chicago, September 17-19, 1951

Diesel Electric Locomotive Batteries

Questions and Answers

Q.—How should battery hydrometer readings be made?

A.—Unless a uniform method is used, a wide variety of results may be obtained from hydrometer readings taken by different men from the same electrolyte. The following procedure is suggested by the Electric Storage Battery Company:

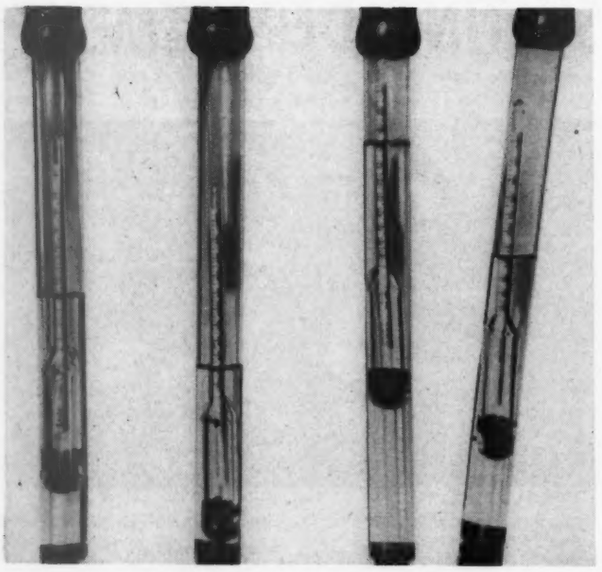
Enough electrolyte should be drawn off to fill the barrel of the syringe to a level which will permit the hydrometer to float freely without touching the barrel at either top or bottom. Correct and incorrect techniques are shown in the figure. The rubber bulb should be allowed to expand completely and the syringe should be held by the neck of the bulb.

Shake the syringe gently to be sure the hydrometer is floating freely. Hold the syringe at eye level. The point at which the electrolyte level appears to intersect the stem of the hydrometer, will indicate the specific gravity readings to be recorded.

Empty the hydrometer syringe completely, making certain that the electrolyte is returned to the same cell from which it was taken. A clean accurate hydrometer syringe must be used. It must be disassembled and washed thoroughly at least once a month.

Avoid any dripping of electrolyte from the hydrometer syringe.

To insure accuracy when water is added, hydrometer



Right and wrong hydrometer positions for specific gravity readings. (Left to right)—hydrometer floating freely in barrel permitting correct reading; insufficient amount of electrolyte makes float rest on bottom of barrel; too much electrolyte makes float touch top of barrel; syringe held at an angle causes float to stick to barrel

readings should be taken before adding water. Water is lighter than electrolyte and will float on top of the electrolyte when added. A day or two is required for water and electrolyte to mix thoroughly, after which hydrometer readings may be assumed to be accurate again.

The fully charged specific gravity varies in different types of batteries and is shown on the battery nameplate. The discharged specific gravity (not shown on the battery nameplate) also varies with the battery type, but is usually around 130 to 140 points lower than the fully charged specific gravity.

The specific gravity, or hydrometer reading, of the electrolyte lowers on discharge and rises again on charge. Consequently, if we know the specific gravity, temperature and height of electrolyte above the splash cover, we can estimate the approximate state of charge, provided that no electrolyte has been lost or added to the cells.

A specific gravity reading 100 points below the full charge value is a warning not only that the battery needs immediate charging, but that the charging equipment probably has failed in some way and should be checked.

The fully charged specific gravity of electrolyte in new batteries is adjusted within the limits shown on the nameplate, and should not require adjusting during the life of the battery, unless electrolyte is actually lost or spilled.

Replacement of spillage should only be made in regular battery shops.

Q.—What accessories are required for battery maintenance?

A.—These are accessories recommended by the Electric Storage Battery Company:

VOLTMETER.—The voltmeter used for checking voltage regulators should have a scale that can be read accurately and easily between 129 and 130 volts.

The same voltmeter can be used for checking individual cell voltages if it has an independent tree-volt scale so that it can be read easily in hundredths of a volt. Accuracy should be within one per cent.

To insure their accuracy, voltmeters should be compared at least twice a year with a standard meter (kept only for checking purposes).

HYDROMETER SYRINGE.—Use a clean, accurate hydrometer syringe for taking specfiic gravity readings.

An 18-in. soft rubber extension with a bent hard rubber measuring nozzle, is a handy addition for reaching otherwise inaccessible vent openings. It is used to measure the height of electolyte, and to take readings of cells in the rear of 4-cell trays where compartments have low overhead space.

HYDROMETER SYRINGE HOLDER.—If the hydrometer syringes are carried on the locomotive, it is suggested that a hydrometer syringe holder, such as the Exide No. 21070, be installed close to the battery. Use of this device will lessen syringe breakage.

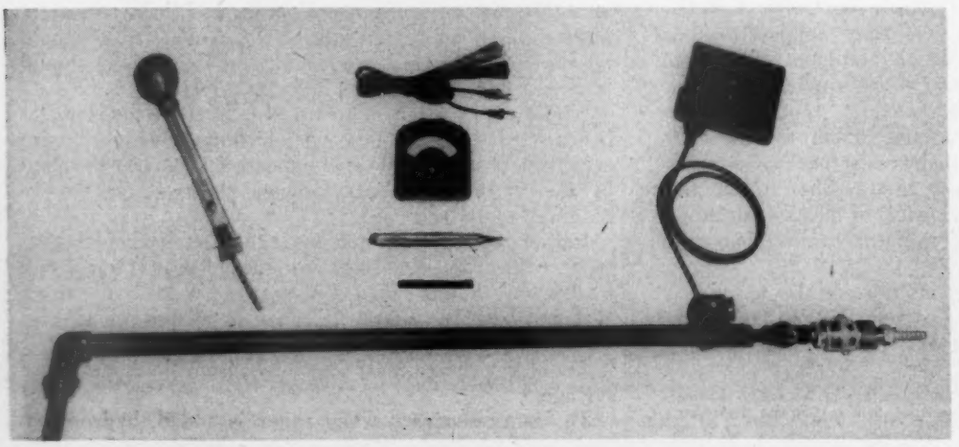
THERMOMETER.—For taking the temperature of electrolyte, use an accurate thermometer. The Exide thermometer also shows hydrometer reading corrections necessary for any temperature of the electrolyte.

ROTATING VENT PLUGS.—A special white porcelain vent plug is suggested for this purpose.

CELL FILLER.—It is recommended that an automatic cell filler be used for adding water to batteries.

LIFTING RIG.—When the design and location of the battery compartment makes necessary the installation and removal of the trays or containers from the top of the compartment, an adequate lifting device should be used.

S. K. LESSEY
The Electric Storage Battery Company



Accessories for locomotive battery maintenance include an automatic cell filler, electrolyte thermometer, a hydrometer syringe and a voltmeter

EDITORIALS

Invention and The Laboratory

One consideration which has long been a hindrance to the advancement of standardization is the fear of the tendency toward stagnation which was characteristic of some early standardization programs. The equipment standardization of the Harriman Lines early in the twentieth century is a case in point. Not only were locomotive classes reduced to the minimum which could meet the needs of the system, but parts were extensively standardized between classes of locomotivs to a point where many thought that the best proportions for each class were sacrificed in the interest of making one style and one set of dimensions for each part fit as nearly all classes of locomotives as physical limitations would permit.

The theory back of this fear was that progress depended upon the invention of improved types of parts or details of design, through which process reliability or operating efficiency or cost of maintenance could be improved. Then, and for some years thereafter, such improvements in design depended upon the exercise of genius on the part of the designer, based upon his experience and the fertility of his imagination. Most of the basic features of today's rolling stock—couplers, air brakes, draft gears, most truck details, and car structures, particularly those of freight cars—were evolved through this process. It is true that, once these things, most of them proprietary, had taken form, they became the objects of intensive refinement by the companies marketing them and in this way vast improvements have been effected. As far as it goes, there can be no substitute for this process.

A significant change has taken place in the conditions affecting the development of industrial products during the last quarter of a century, however. It was during that period that research in pure science, particularly in applied science, became a dominant feature in determining the character of industrial products. While invention is still a factor in the process, and probably always will be, operating experience and genius are no longer adequate qualifications to support invention. The day of hunches and conclusions based on reasoning from purely empirical premises is over. As the period of development of basic designs has given way to that of refinement, extensive reservoirs of specialized knowledge have been developed through research. The need for further knowledge is never satisfied and, as time goes on, it can only be satisfied by more and more intensive research. Thus the laboratory has become an essential factor in the inventive process.

As the fields of industrial research have widened, the need for it in the railroad field has spread beyond the builder or supplier of materials and equipment to the user as well. The cost of such research is too great to permit much of it to be carried on except on an industry-wide basis. The results already attained by the railroads through the A.A.R., both with respect to track and rolling stock, have been such as to insure its extension.

As industry-wide research projects furnish accurate factual answers to more and more problems, the one best solution in each case will establish a new standard. Standards thus established become signs of progress, not of stagnation.

Standardization for Electric Traction

There is much that is significant in the development of two new types of electric locomotives recently placed in service by the Pennsylvania. Both types take power from an 11,000-volt, 25-cycle overhead contact system. One type, designed by the General Electric Company, and described in this issue, employs a newly-developed series a.c. motor which is capable of delivering more power at lower motor speeds than other motors of this type, and making the locomotive better suited to freight service. The other type of locomotive, designed by the Westinghouse Electric Corporation is a rectifier type which employs a transformer and sealed Ignitron mercury-arc rectifiers to produce direct current for the traction motors. These locomotives will be described in an early issue of *Railway Mechanical and Electrical Engineer*.

Railroad representatives state that to date both types of locomotives have indicated that they are capable of hauling freight more efficiently than the older electric locomotives or than a diesel-electric locomotive of comparable size. Between the manufacturers' representatives, there is much contention as to which is the better locomotive, but these arguments lose much of their force when the railroad points out that the two are not really comparable.

The significance of the situation is this. Many different types of electrification and many more types of electric locomotives are in service all over the world. Practically all of them have been able to turn in a respectable performance record. Some improvement, perhaps ten per cent, might be made by changing our present power systems or locomotives to some other type. A much greater

improvement, let us say 30 per cent, could be effected by greater standardization, permitting greater quantity production of parts and more interchangeability of motive power. The diesel-electric locomotive has demonstrated both of these factors most effectively.

If straight electrification is again to find a place in this country, its reinstatement will be hastened by a reduction of costs. Some 70 per cent of our electric motive power now operates under high-voltage a.c. contact systems. Since all systems work, should this not now be regarded as American standard, permitting further development to start from this point? Unquestionably, in the early days, electric traction was considerably retarded by "The Battle of the Systems." If the manufacturers could not agree on a power system, what could the railroads think of the idea of electrification as a whole?

Beginning from there, all the necessary types of motive power are available. A.C. series motors have proven their adaptability to both locomotives and multiple unit cars. the rectifier is in service on an m.u. car and on locomotives. Those who prefer motor-generator type locomotives can have them if they wish.

Contact system power at 50 cycles is being tried in Europe. It has been proposed that we might use our present standard of 60 cycles in this country. It does not seem to have too much in its favor since power companies would probably object to supplying single-phase power, but it could be applied to the same type of contact system.

The diesel has found favor because of its high efficiency and, in relation to straight electrification, for its ability to go anywhere without an overhead wire, and because large initial investments for power distribution are not required. If electrification ever comes back in volume in this country, it will be because of a considerable increase in the price of oil in comparison with the price of electric power. Such a return will be hastened if agreement on power supply is accepted and progress toward standardization of equipment can be assured.

What Ten Years Can Do?

Speculation on the future is always interesting and there are those who today are watching the trend of motive power changes that wonder just where the replacement of steam power by diesel-electric is going to bring us out five or ten years from now. In the absence of any predictions it is possible that an examination of the statistics of motive power for the last ten years may serve as the basis for estimates of future possibilities.

The accompanying table of locomotive ownership has been prepared to show the changes that have actually taken place between 1941 and 1951 and the changes during the year 1951. These figures give a brief picture of the ownership situation as of Jan. 1 of this year and it is interesting to note that while there are 12,326 diesel powered locomotives, composed of 17,619 units, there are still 21,200 steam locomotives on the Class I railroads, a decrease of 18,655 since Jan. 1, 1941.

More interesting still are the performance figures which now show, as of October 1951, that in freight service the diesel is handling 50 per cent of the locomotive mileage as against 48 per cent for steam. In passenger service it is 63 per cent for diesel and 30 per cent for steam and in yard switching service it is 61 per cent of the yard switching hours for the diesel and practically all of the remainder for steam power.

Once again it is worth while to call attention to the fact that there are still 21,200 steam locomotives left and for those that are looking forward to the day when all the steam locomotives are gone the fact should be borne in mind that the replacement ratio is changing all the time. In the case of switchers 6,088 diesel switchers have been installed in 11 years and 3,715 steam switchers have been retired—but there are still 3,531 steam switchers left. In this case it has not been entirely a job of replacing steam by diesel for as the diesel switcher came into the field its usefulness, coupled with increases in traffic developed many new uses for the diesel electric type of switcher so that if and when all of the steam switchers are replaced by diesel-electrics there will probably be several hundred more locomotives of this latter type than there were originally steam. This, too, is worth keeping in mind.

OWNERSHIP OF MOTIVE POWER

	Jan. 1, 1952	Jan. 1, 1951	Jan. 1, 1941
Steam Locomotives			
Passenger	3,106	3,791	6,921
Freight	13,644	16,214	24,588
Pass. or Freight	919	1,093	1,200
Switch	3,531	4,167	7,246
TOTAL	21,200	25,265	39,855
Diesel Electric			
Passenger	1,200	953	116
Freight	3,814	2,698	11
Pass. or Freight	536	366	0
Switch	6,776	5,813	688
TOTAL LOCOS.	12,326	9,830	815
TOTAL UNITS	17,619	14,160	(*)

* Data not available.

These statistics are offered for whatever value they may be. There are many people who already have observed that the rapid installation of diesel power is creating a situation where, at some not too distant date a peak will have been reached in the installation of diesel power. Many estimates have been made and some are willing to venture the prediction that when the replacement of steam by diesel is complete—this is not a prediction that there will be *no* steam locomotives left in service—there will be somewhere between 25 and 30 thousand diesel units.

This guess ignores factors which do not seem to be too clear at the moment—the question of railroad traffic, the increasing age of diesel power and the ability of the railroads to get more service out of each individual unit than they already have done. There is also the ever-present possibility that some new type of motive power, be it gas turbine, atomic locomotive or whatever the future may bring, may break upon the scene as did the diesel-electric and upset all of the statistics once again.

NEW DEVICES

Anti-Corrosion Metal Wash Primer

Produced by the Vorac Co., Rutherford, N. J., this primer, based on Vinylite resins, fills a need for military and civilian production and can be used under practically all types of coatings. The wash primer, designated Vorac H-400 by its manufacturer, requires no oxidation or polymerization, as films are formed by the evaporation of the solvents.

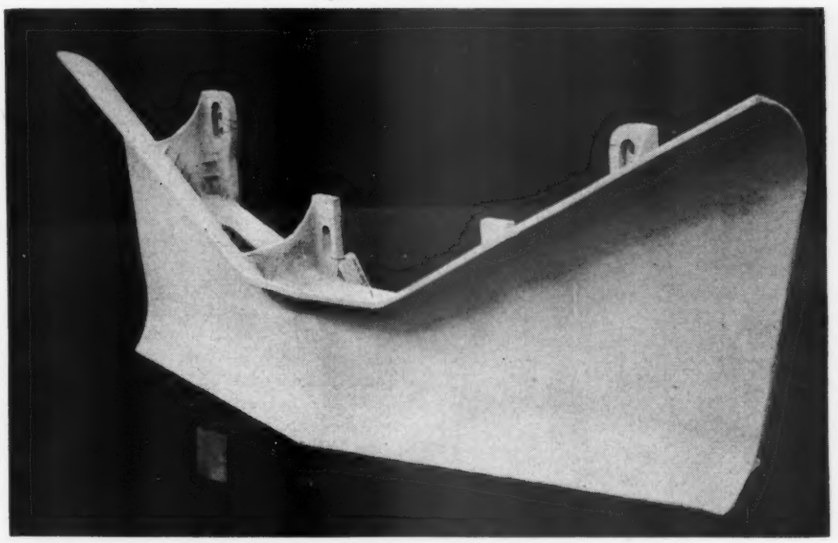
A zinc chromate compound, Vinylite resin-base wash, is designed to provide an adherent base coating on most metals and alloys. It is a metal conditioner, as well as primer, applied only to clean surfaces since it does not replace degreasing or sand blasting. The compound does, however, replace phosphate treatment and should not be applied over a phosphated surface.

Wash primer is always employed in conjunction with one or more top coats. Used as soon as possible following metal cleaning, the primer which dries in less than 30 min. will for a time prevent rusting under usual weather conditions. The composition is supplied in two parts for mixing at the time of use. It is applied by dipping, brush or spray, depending on the objects to be coated.

◆

Cast Steel Pilot Snow Plow

The General Steel Castings Corporation, Granite City, Ill., has recently developed a pilot snow plow for application to diesel locomotives in either switching or road service. In use on a number of railroads, these pilot plows are said to be showing good results in keeping rails clear of drifting snow and eliminating the repeated use of large snow-removing equipment.



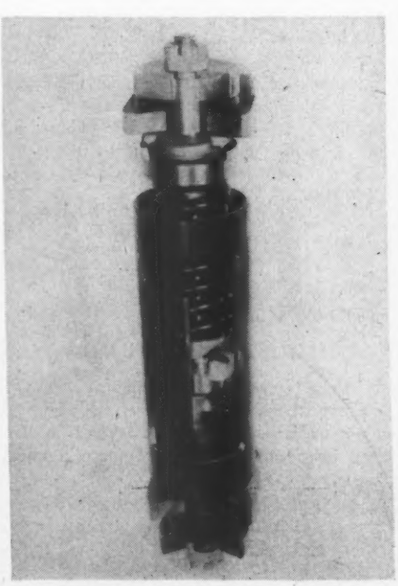
Commonwealth pilot snow plows are rugged one-piece steel castings designed so that snow is effectively removed from the rails without causing interference with traction motors or obstructing cab steps. Provision is made for ample adjustment to the desired height above the rail. For seasonal use they may be easily applied, removed and reapplied, but, if permanently installed, they serve a year-round purpose as strong deflecting pilots which clear the way of obstructions, substantially reducing the possibility of accident or derailments. Providing economical service, these sturdy one-piece castings are designed to withstand great abuse with practically no maintenance.

The new pilot snow plow does not interfere with normal coupling operations and, when locomotive units are coupled together, there is sufficient clearance for negotiating 130-deg. curves. Pilot plows may be applied at either or both ends of the diesel, depending upon service requirements. Designs are available for almost all standard types of diesel switcher or road locomotives.

Houdaille Friction Snubber

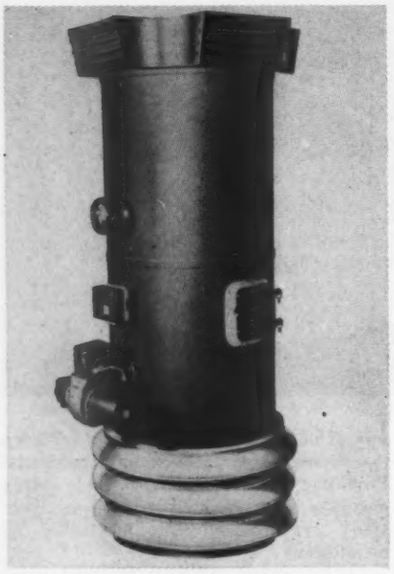
The friction-type snubber, made by the Houdaille-Hershey Corporation, Buffalo, N. Y., and sold by the General Steel Castings Corporation, is a simplified shock absorber which controls the movement of railway truck coil springs, substantially reducing excessive damage to lading and discomfort to passengers.

As shown in the accompanying phantom view, the snubber contains three segmental shoes faced with special, long-wearing molded brake lining material, attached by the Chrysler cycle-welding process. The shoes are forced outward against the barrel under constant pressure produced by a precompressed coil spring. Just the right combination of material in the lining and barrel gives uniform frictional resistance, both at the start and during movement of the truck springs, to allow smooth control of vertical motions. The amount



of snubber friction is precalibrated to match any given spring group.

The design of the snubber mountings provides universal-joint action to accommodate any change in angularity of the snubber due to relative movements between the spring plank and bolster. Rubber compression blocks hold the double-faced rockers in continuous solid contact with the snubber mounting brackets. By this means, any vertical movement of the bolster is controlled by the friction snubbers. Shocks are dissipated before they reach the truck bolster.



Direct-Fired Heaters

Self-contained, direct-fired heaters for use in engine houses, diesel repair shops, freight stations, and other railroad structures, have been designed by the Thermobloc Division of Prat-Daniel Corporation, South Norwalk, Conn.

The unit circulates heated air at working levels under automatic controls for maintaining even temperatures in building having heavy in and out traffic. The units require no complicated piping, duct work or radiator installations and are available in floor or ceiling suspended models.

Connecting the units with an oil or gas line and electric power places them in readiness to operate and tests indicate that the working area will heat up about five minutes after the units are started. Operation is entirely automatic.

◆

Non-Alkaline Cleaning Compound

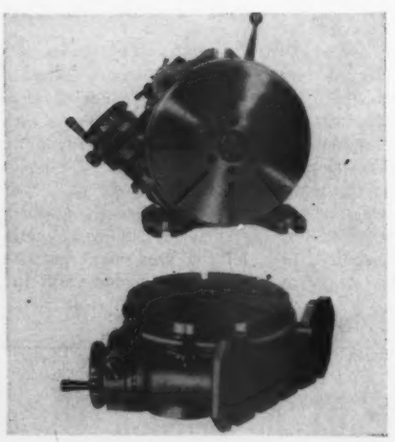
A steam cleaning compound which will improve the cleaning operation wherever steam or vapor cleaning is carried on, has been introduced by the Magnus Chemical Co., Garwood, N. J.

The solution named Magnus 72 contains no alkaline salts. It is neutral in reaction and will not dull or streak good paints. Aluminum and other soft metals which are attacked by alkaline salts are untouched by this product. It generates no objectionable fumes and can be used indoors where ordinary steam cleaners cannot be employed.

The liquid concentrate cleaner cannot clog steam cleaning equipment. It tends to protect interior unpainted surfaces against rust and corrosion due to unsaponified oil content, which works to prevent rust formation on unprotected metal surfaces.

In using Magnus 72, 2-3 qt. of the concentrate are poured into the tank of the steam cleaning machine and the tank filled with water. Where solution tank is separate, mix 2-3 qt. of the solution with 50 gal. of water.

◆



Optical Indexing Table

The Griswold indexing table is designed to provide greater accuracy with milling machines, jig borers and similar machines for indexing and rotary milling. The table may be used either in a vertical or horizontal position.

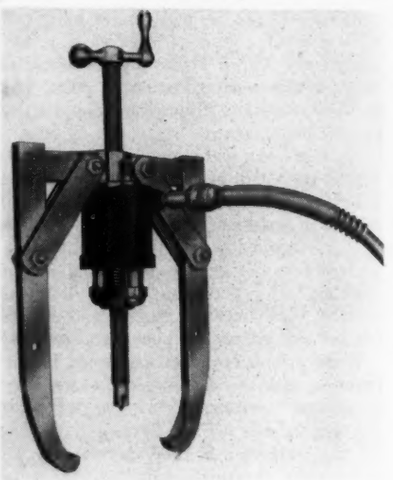
An engraved glass degree scale is observed directly through a compact telescope which, in conjunction with circular dial, makes possible readings accurate to .0005-in. at periphery of 12-in. circle. As the diameter of the circle decreases, accuracy increases. The reading is made at a normal viewing distance.

Effects of mechanical wear, backlash and oil film thickness are eliminated. Reproducible results can be obtained in either direction.

The turn table is supported at its periphery about its entire circumference. The forged spindle is mounted on especially selected, preloaded taper roller-bearing. Anti-friction bearings are used for all rotating shafts. A clutch permits hand rotation of turn table to facilitate position. Locking a spindle to prevent rotation does no disturb table setting.

Griswold indexing tables are made by F. T. Griswold Mfg. Co., Wayne, Pa.

◆



Power-Twin Puller

Three sizes of the Grip-O-Matic pullers developed by the Owatonna Tool Company, 410 Cedar street, Owatonna, Minn., can now be used with the company's new Power-Twin hydraulic puller. Only slight changes are necessary to change over pullers Nos. 1003L, 1003½ and 1003½-L to fast-operating hydraulic power to make them more effective and efficient and to increase their range of utility.

The Power-Twin puller speeds up the work, eliminates torque, and is safer, because of the remote control feature. The ram of the puller can easily and quickly be detached from the Grip-O-Matic puller and used just as effectively on OTC push-pullers or on a bench or pedestal press.

◆

Synthetic Rubber Packing

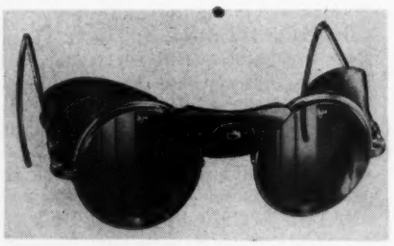
The replacement of leather packing with synthetic rubber packing in the air cylinders of air-operated control devices on new Alco-G.E. locomotives helps power contactors, reversers and dynamic braking switches operate more smoothly and more uniformly, according to engineers of General Electric and American Locomotive Company. Adapter kits for each control device have been designed for locomotives now in service.

Control devices using the new synthetic rubber packing require lubrication only once a year, while leather-packed devices are usually lubricated six times a year. The danger of faulty contacts in cold

weather due to improper lubrication is said to be eliminated by the new-type packing.

Each adapter kit consists of the materials necessary to convert one control device to synthetic packing. To insure correct identification for easy future renewal parts ordering, each kit also includes a new nameplate.

◆



Adjustable Welding Goggles

A welder's goggle, featuring removable and adjustable binder-type leather side shields has been introduced by the Americal Optical Co., Southbridge, Mass.

This goggle, series 3081A, can be adjusted for fit and comfort by loosening the endpiece screws. By removing these screws, side shields can be taken off for cleaning, sterilizing, or replacing. It replaces the series 3081 welder's goggle.

The side shields are made of soft leather to provide comfort and protection against heat, harmful light and flying particles. The cylinder bridge and reinforcing bar are also covered with leather. These side shields are also available for its No. 3080 goggle according to the manufacturer.

◆

Lubricant for High Temperatures

An anti-friction bearing lubricant—Texaco High Temp Grease—has been announced by The Texas Company, New York, which exceeds established military and industrial standards in affording unusual protection at temperatures up to 300 deg. F. for continuous operation and 350 deg. F. for intermittent operation.

During the laboratory development of Texaco High Temp Grease a variety of standard and special tests for anti-friction bearing operation revealed that the new grease has excellent oxidation resistance. It outran the hours-to-failure criteria of normal tests at 300 deg. F. and continued to exceed test specifications at even higher temperatures. An unusual characteristic of the new grease is said to be the efficiency of its performance at high speeds as revealed in special ultra-high-speed endurance tests developed at Texaco's Beacon Laboratories.

Its water resistance makes Texaco High Temp Grease applicable in operations where long retention of grease and resistance to washing out are factors.

◆

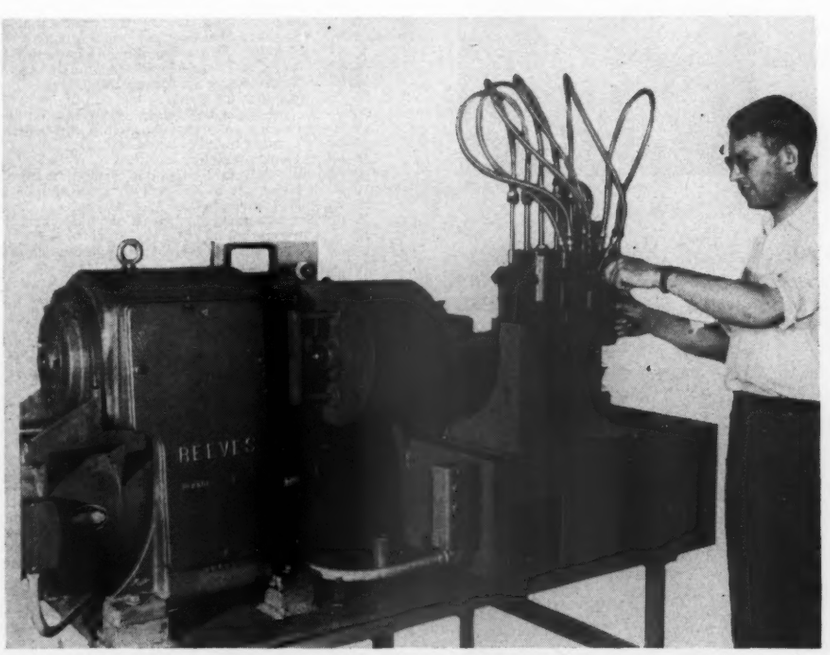
Surge Comparison Tester

A new industrial electronic surge comparison tester is available from Westinghouse Electric Corporation. It is used to locate insulation faults and winding dissymmetries in motors, a.c. and d.c. generators, transformers and coils.

The surge comparison tester, available in either mobile or portable models, is compact and movable, and has adequate surge voltage characteristics for most insulation tests. A wide flexibility in application and simplicity of operation are designed to make the surge tester adaptable to both manufacturing and repair work.

The tester simultaneously tests turn-to-turn, phase-to-phase, and coil-to-ground insulation with potentials high enough to simulate power circuit transient stresses. With every test setup, high-frequency and high-potential qualitative tests of resistance, impedance, and turn balance are made, and the results are obtained by a single scope observation. High turn-to-turn voltages are applied without excessive winding-to-stresses. Non-destructive testing is assured even on fractional horsepower motors and generators, and destructive fault location is possible in many cases.

Portable model of surge comparison tester



Standardized Fuel Pump Testing Procedures

Research by the Cummins Engine Co., Inc., Columbus, Ind., has resulted in standardization of their diesel fuel pump testing equipment and testing apparatus.

This method developed by the study is now being utilized by Cummins dealers who maintain service locations from coast-to-coast. The need for standard testing is recognized, as hydraulic characteristics may differ between fuel pump test stands and sometimes cause variable quantities of fuel to be delivered.

Two fuel pump models, the single disc and the DD (double disc) are offered with the fuel system.

Single-plunger, low-pressure, distributor-type fuel pumps measure the fuel charge for all cylinders and assure that each injector receives the predetermined amount of fuel at any required engine speed and load within its rating.

NEWS

Keller Succeeds Jackson As Research Director

W. M. KELLER, assistant mechanical engineer, Pennsylvania, has been appointed director of mechanical research, A.A.R. Mechanical Division, succeeding J. R. Jackson who retired on December 31. Mr. Keller will have jurisdiction over all phases of research conducted by the Mechanical Division, including refrigerator car tests and studies. His headquarters will be in Chicago.

Mr. Keller was born on August 29, 1901, in Pittsburgh. He studied engineering at

W. M. Keller

the University of Pittsburgh from 1924 to 1926 and obtained the degree of M.E. at Pennsylvania State College in 1932. He entered the employ of the Pennsylvania at

J. R. Jackson

the Altoona Works in September, 1919, as an apprentice. In 1926 he became inspector, test department; in 1938, coal inspector, test department; in 1939, assistant engineer, test department; in 1941, foreman, mechanical engineer; in 1944, general foreman, car design. On November 1, 1947, he was appointed assistant mechanical engineer. Mr. Keller is a member of the Franklin Institute and the American Society of Mechanical Engineers, and has served on the Sub-Committee on Refrigerator Car Design of the Mechanical Division, A.A.R.

Mr. Jackson, who was born on May 5, 1886, in Ft. Wayne, Ind., was educated at Purdue University where he received the degree of B.S. in M.E. in 1910, and the degree of M.E. in 1915. He began his railroad career on the Pennsylvania at Ft. Wayne, serving as a machinist apprentice from 1903 until 1906 and during the summers of 1907-09. From June 1910 until 1917 he was in the test and inspection department of the Atchison, Topeka & Santa Fe where he became assistant engineer of tests. He was commissioned a captain in the U.S. Reserve in 1917 and was promoted to Major, Ordnance, U.S. Reserve, in 1919. On March 1, 1919, Mr. Jackson was appointed mechanical engineer, Division of Operation, U.S.R.A., at Washington, D.C. In 1920 he became associated

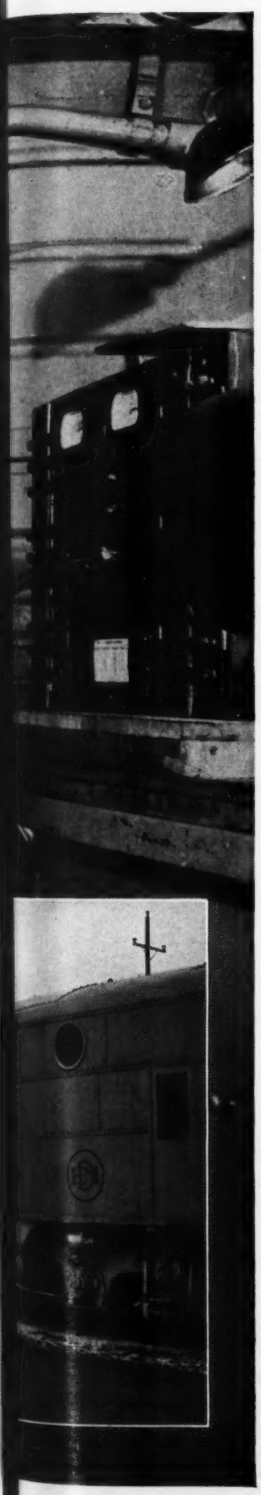
SELECTED MOTIVE POWER AND CAR PERFORMANCE STATISTICS

FREIGHT SERVICE (DATA FROM I.C.C. M-211 AND M-240)

Item No.		Month of September		9 months ended with September	
		1951	1950	1951	1950
3	Road locomotive miles (000) (M-211):				
3-05	Total, steam	22,950	30,717	227,849	256,502
3-06	Total, Diesel-electric	23,551	18,492	198,738	152,690
3-07	Total, electric	770	859	7,309	7,386
3-04	Total, locomotive-miles	47,271	50,075	433,918	416,625
4	Car-miles (000,000) (M-211):				
4-03	Loaded, total	1,732	1,792	15,461	14,320
4-06	Empty, total	900	885	7,854	7,518
6	Gross ton-miles-cars, contents and cabooses (000,000) (M-211):				
6-01	Total in coal-burning steam locomotive trains	42,788	53,690	398,273	425,168
6-02	Total in oil-burning steam locomotive trains	11,314	14,299	108,306	113,123
6-03	Total in Diesel-electric locomotive trains	66,505	53,419	555,792	432,902
6-04	Total in electric locomotive trains	2,152	2,339	20,027	19,578
6-06	Total in all trains	122,767	123,775	1,082,516	990,984
10	Averages per train-mile (excluding light trains) (M-211):				
10-01	Locomotive-miles (principal and helper)	1.04	1.05	1.04	1.05
10-02	Loaded freight car-miles	40.60	40.10	39.60	38.40
10-03	Empty freight car-miles	21.10	19.80	20.10	20.20
10-04	Total freight car-miles (excluding caboose)	61.70	59.90	59.70	58.60
10-05	Gross ton-miles (excluding locomotive and tender)	2,880	2,769	2,771	2,659
10-06	Net ton-miles	1,364	1,296	1,299	1,211
12	Net ton-miles per loaded car-mile (M-211)	33.60	32.30	32.80	31.50
13	Car-mile ratios (M-211):				
13-03	Per cent loaded of total freight car-miles	65.80	66.90	66.30	65.60
14	Averages per train hour (M-211):				
14-01	Train miles	17.10	16.70	16.90	16.90
14-02	Gross ton-miles (excluding locomotive and tender)	48,514	45,555	46,314	44,422
14	Car-miles per freight car day (M-240):				
14-01	Serviceable	47.40	48.80	46.00	44.70
14-02	All	45.10	46.10	43.90	41.70
15	Average net ton-miles per freight car-day (000) (M-240)	111.10	112.00	111.90	110.10
17	Per cent of home cars of total freight cars on the line (M-240)	37.80	35.80	37.20	42.40
	PASSENGER SERVICE (DATA FROM I. C. C. M-213)				
3	Road motive-power miles (000):				
3-05	Steam	8,730	11,913	92,496	105,280
3-06	Diesel-electric	16,782	15,052	145,663	130,236
3-07	Electric	1,577	1,602	14,571	14,409
3-04	Total	27,090	28,568	252,729	249,926
4	Passenger-train car-miles (000):				
4-08	Total in all locomotive-propelled trains	270,056	279,578	2,462,736	2,408,620
4-09	Total in coal-burning steam locomotive trains	45,894	63,492	484,802	541,704
4-10	Total in oil-burning steam locomotive trains	30,437	38,481	298,249	332,448
4-11	Total in Diesel-electric locomotive trains	176,224	160,230	1,524,001	1,379,438
12	Total car-miles per train-miles	9.78	9.64	9.59	9.44
	YARD SERVICE (DATA FROM I.C.C. M-215)				
1	Freight yard switching locomotive-hours (000):				
1-01	Steam, coal-burning	1,053	1,457	10,949	12,689
1-02	Steam, oil-burning	221	273	2,136	2,180
1-03	Diesel-electric[1]	2,953	2,659	26,295	22,017
1-06	Total	4,250	4,419	39,610	37,129
2	Passenger yard switching hours (000):				
2-01	Steam, coal-burning	37	50	421	527
2-02	Steam, oil-burning	12	14	116	119
2-03	Diesel-electric[1]	239	234	2,172	2,037
2-06	Total	321	332	3,010	2,988
3	Hours per yard locomotive-day:				
3-01	Steam	7.30	8.70	7.80	7.90
3-02	Diesel-electric	16.90	17.90	17.20	17.40
3-05	Serviceable	14.20	14.70	14.40	14.00
3-06	All locomotives (serviceable, unserviceable and stored)	12.20	12.70	12.40	11.80
4	Yard and train-switching locomotive-miles per 100 loaded freight car-miles	1.70	1.71	1.77	1.79
5	Yard and train-switching locomotive-miles per 100 passenger train car-miles (with locomotives)	0.74	0.74	0.76	0.77

[1] Excludes B and trailing A units.

"blood pressure" on the ru



UNLESS you've made a trip in this car, you've never seen anything quite like it before.

It's Electro-Motive Division's Engineering Test Car—a veritable "rolling laboratory" equipped to obtain accurate and detailed information on all phases of locomotive performance.

Designed and built by Electro-Motive three years ago, this car has already traveled more than 150,000 miles on American railroads—checking locomotive performance in every type of terrain and under all kinds of actual working conditions.

It is equipped with scores of intricate electrical counters, temperature recorders and timing devices to gauge and record anything needed that can be measured by an electrical current.

It carries instruments capable of measuring the temperature of traction motor bearings while operating at high speed.

It measures currents in power circuits during transition.

It tells us axle stresses under rolling loads—and measures rail stresses as trains pass over.

It even tells us the locomotive's "blood pressure," if you will—checking and recording the temperature of oil and water throughout the engine.

Another of Electro-Motive's many plus services to railroads, this on-the-rail testing gives both our customers and our engineers a wealth of information that couldn't be obtained in any other way. You see the results in longer life of GM Diesel locomotive parts—in a continuous stream of improvements that lift the performance standards of General Motors locomotives to even higher levels.

GENERAL MOTORS LOCOMOTIVES

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS
La Grange, Illinois · Home of the Diesel Locomotive
In Canada: GENERAL MOTORS DIESEL, LTD., London, Ontario

with the Lewis Engineering Company, Chicago and Toronto, as mechanical engineer, being later appointed chief engineer. He became a copartner of Pioneer Precooling Plants at Lodi and Napa, Cal., in 1923; on July 1, 1925, engineer of tests of the Missouri Pacific Lines, and on September 1, 1946, mechanical engineer of the Mechanical Division, A.A.R.

Mr. Jackson has actively served on various committees of the American Society for Testing Materials. As a member of the Mechanical Division, A.A.R., he has served on the Committee on Development of Hot Box Alarm Devices, Committee on Axle Research, Committee on Crank Pin Research, and as chairman of the Committee on Journal Bearing Development. Mr. Jackson is a member also of the Locomotive Maintenance Officers' Association; Western Railway Club; Car Department Officers' Association; the Railway Fuel and Traveling Engineers' Association, of which he was president in 1938, and the American Society of Mechanical Engineers, of the Railroad Division of which he was chairman in 1943.

P.R.R. Tries Two New Locomotive Designs

FOUR new electric freight locomotives, with many modern developments to provide more efficient and better service, have been built for the Pennsylvania by General Electric and Westinghouse, working in collaboration with railroad engineers.

Three locomotives are already in fast freight service in the road's electrified territory and the fourth is under tests. They represent a total cost of about $3,000,000 and each consists of two identical streamlined units similar in appearance to diesels.

Two locomotives, built by Westinghouse, employ the first application to locomotives of the ignition rectifier, an electronic principle using large mercury arc tubes to convert the 11,000-volt, 25-cycle, a.c. power from the contact system to direct current for the motors. The railroad and the electric company cooperated in adapting it successfully to an electric suburban car after its initial development for industrial usage, and then further refined it for use on locomotives, improving and simplifying the method of power conservation. Rated at 6,000 hp. continuously, each locomotive is 124-ft. long, has 44-in. driving wheels, and weighs about 755,000 lb.

The other two locomotives built by General Electric, which are described elsewhere in this issue, develop 5,000 hp. each continuously and up to 10,000 hp. during acceleration or when ascending grades. Work on their design began in 1937 but was interrupted by World War II. The parts have been built as simple as possible, and adequate space has been provided within the locomotive to facilitate inspection and maintenance. Each is 108½ ft. long, has 48-in. driving wheels, weight 491,000 lb. and will multiple with many existing electric freight units.

The locomotives have traction motors driving all wheels, similar to modern freight diesels. The full weight of the locomotives is thus utilized to produce maximum tractive force. They are equipped with dynamic braking, in addition to air brakes.

ORDERS AND INQUIRIES FOR NEW EQUIPMENT PLACED SINCE THE CLOSING OF THE JANUARY ISSUE

DIESEL-ELECTRIC LOCOMOTIVE ORDERS

Road	*No. of units*	*Horsepower*	*Service*	*Builder*
Baltimore & Ohio	37[1]	1,500	Freight	Electro-Motive
	12[1]	1,600	Freight	Alco-G.E.
	6[1]	1,600	Freight	Baldwin-Westinghouse
Reading	12[2]	....	.....	Alco-G.E.
	8[2]	....	.....	Electro-Motive
	4[2]	....	.....	Baldwin-Westinghouse
Transportation Corps	14[3]	44-ton	.....	General Electric
	3[3]	25-ton	.....	General Electric
	24[3]	80-ton	.....	General Electric

FREIGHT-CAR ORDERS

Road	*No. of cars*	*Type of car*	*Builder*
Denver & Rio Grande Western	500[4]	70-ton gondola	General American
Quebec, North Shore & Labrador	15	Caboose	Canadian Car & Fdry.
Toronto, Hamilton & Buffalo	100[4]	70-ton gondola	National Steel Car

[1] To be leased from the Equitable Life Assurance Society. To be delivered between April and September.
[2] To cost $3,910,000. Most of the units will be used in road freight-switching service, with a few designed for passenger service. Deliveries expected to be completed in 1952.
[3] Eleven of the 14 44-ton units of 0-4-4-0, dual engine type, are for use by the Air Forces and three for the Navy. Two of the 14, for which the bid price was $63,100 each, will be delivered in March and the remaining 12 at the rate of two per week, beginning the last week of October. One of the three 25-ton locomotives, for use by the Air Forces, is scheduled for April delivery; the remaining two, for June. The bid price on each of these was $19,835. Fifteen of the 24 80-ton 0-4-4-0 dual engine type locomotives, are for the Navy and nine for the Air Forces. Delivery will be at the rate of two per week, starting in nine months. The total contract value of these locomotives is $1,893,480.
[4] For delivery during fourth quarter of 1952.
[5] For 1953 delivery.

NOTES:

Erie.—The Erie's board of directors has authorized purchase of 42 diesel-electric locomotive units costing $6,000,000. Also authorized are additional diesel servicing facilities to cost $1,500,000. The motive power will include 30 1,500- and 1,600-hp. road-switching units and 12 1,000- or 1,200-hp. switching units. Maintenance facilities will be constructed at Brier Hill, Ohio, Kent and Meadville, and present facilities at the Cleveland diesel shop will be extended. "This purchase will be our last big bite toward complete dieselization," Paul W. Johnston, Erie president, said. "It will eliminate all steam service except for short-haul commuter service in the New Jersey area, which is now 60 per cent diesel equipped.

SUMMARY OF MONTHLY HOT BOX REPORTS

Month	Foreign and system freight car mileage (total)	Cars set off between division terminals account hot boxes			Miles per hot box car set off between division terminals
		System	Foreign	Total	
July, 1950	2,745,932,894	....	.....	23,957	114,619
August, 1950	2,937,455,020	7,422	15,490	22,912	128,206
September, 1950	2,974,297,739	6,541	12,881	19,422	153,141
October, 1950	3,165,997,915	4,343	8,935	13,278	238,439
November, 1950	2,868,871,913	2,536	5,331	7,867	364,672
December, 1950	2,813,042,212	2,278	5,968	8,246	341,140
January, 1951	2,840,847,511	2,870	8,436	11,306	251,269
February, 1951	2,425,226,454	4,528	14,063	18,591	130,452
March, 1951	3,063,173,942	3,667	10,078	13,745	222,857
April, 1951	2,996,562,763	3,702	8,914	12,616	237,521
May, 1951	3,013,634,782	5,631	13,737	19,368	155,599
June, 1951	2,874,873,495	7,074	15,376	22,450	128,057
July, 1951	2,768,920,095	8,886	18,823	27,709	99,929
August, 1951	3,009,371,111	9,023	19,092	28,115	107,038
September, 1951	2,925,570,545	6,472	13,565	20,037	146,008

On the Track of Cheaper Diesel Fuel

THE Denver & Rio Grande Western—which pioneered in the use of spectrographic analysis of diesel lubricating oils, not only on quality control but for control of wear rates and mechanical performance of locomotives—is now adding analysis by electronic microscope to its techniques. Such analysis in cooperation with oil producers having shown promise, the railroad has now purchased its own electronic microscope equipment for installation in its laboratory at Denver.

The railroad, according to Ray McBrian, engineer of standards and research, expects to use this microscope in the study of diesel fuels as well as in further research on lubricants. This inquiry, augmented by the research work on ignition improver, pour-point depressants and other similar studies, will be directed to the development, if possible, of a satisfactory diesel fuel based on low cost residual oils of high B.t.u. content.

In cooperation with engine builders and oil refiners the railroad hopes to prove the availability of lower priced fuel. Since a price reduction of only half a cent per gallon would save the railroad $150,000 annually, the potential reward is considered highly attractive in ratio to the relatively slight outlay required.

Mechanical Division Circular Letters

Four circular letters were issued by the A.A.R. Mechanical Division on January 7 relating to more or less important details of mechanical department work.

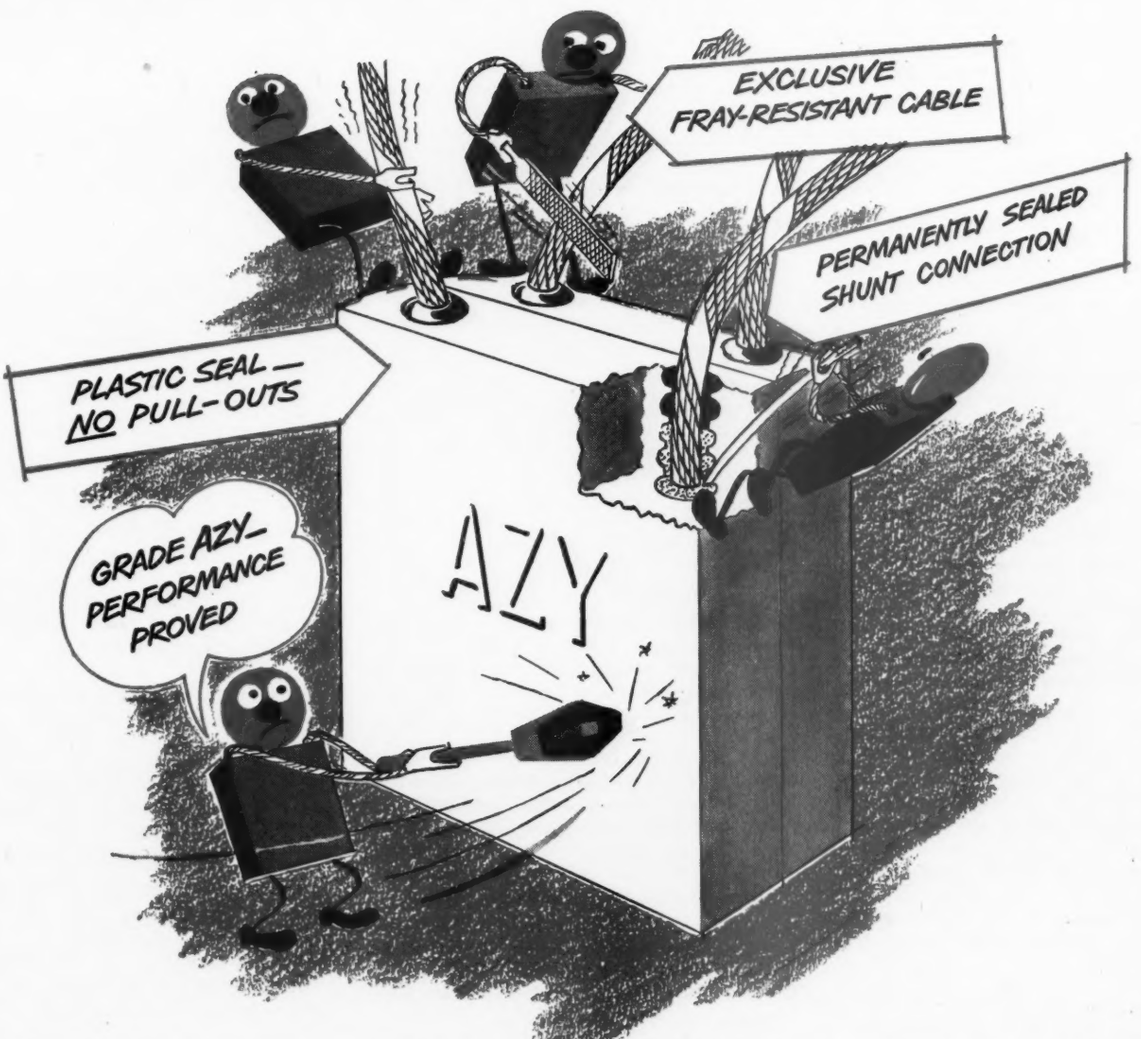
The first letter File No. L-44 (c-709) related to the use of reclaimed waste from diesel engine lubricating filters for journal box packing and recommended strongly against the use of this waste unless it fully meets the requirements of Specification EM-910-50.

The second letter File No. ST-1-101

YOU ASKED FOR IT!

NATIONAL CARBON HAS IT!

...THE BEST D-E TRACTION MOTOR BRUSH MONEY CAN BUY!



• You wanted *longer service* and *freedom from breakage,* with no sacrifice in *commutation.* NATIONAL CARBON gave you AZY—the only grade having all three.

You wanted *an end to shunt connection pull-outs.* NATIONAL'S new, Permanently-Sealed Connection withstands all conditions. Of the millions already in service, not one connection failure has been reported.

You demanded *relief from cable fraying.* HERE IT IS! NATIONAL'S exclusive fray-resisting shunt cable adds the final touch to completely dependable brush performance on D-E Traction Motors.

Don't forget, too, that these STANDARDIZED brushes are manufactured for stock—answer your requirements of uniformity and immediate availability. You get *better brushes* . . . at a *better price* . . . in a *better package.*

ADD THEM UP. THEY TOTAL THE FINEST BRUSH MONEY CAN BUY.

BUY NATIONAL STANDARDIZED BRUSHES FOR MOST EFFICIENT MOTOR AND GENERATOR OPERATION.

The term "National" and the Silver Strand Cable device are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, New York

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco.
In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg.

(c-706) referred to the maximum permissible throw of 3/8 in. at axle center after rough turning of journals and wheel seats and insists that this requirement be met for the axles of all cars to be acceptable in interchange. It requests that the secretary's office be advised of all instances in which axle manufacturers refuse to accept orders for axles without some waiver or modification of this A.A.R. requirement.

A third letter File No. PC-2246 (c-711) specified price increases for car repair labor under interchange rules varying from 6 per cent for some air brake repairs to 21 per cent for labor per hour and 27 per cent or more for repacking journal boxes dependent upon journal size.

The fourth letter File No. L-95 (c-707) related to the quality and condition of journal bearings received from manufacturers and showed in one check of 5,000 bearings a rejection of 278 or 5.56 per cent due to a number of mechanical defects, the most numerous of which were pin holes in linings, dirty castings, tapered bores and shrinkage. This letter recommended the exercise of exceptional care in acceptance of journal bearings from foundries to assure satisfactory performance and the avoidance of hot box difficulties.

Combined Electrical Sections Appoint Secretary

S. W. MARRAS, junior engineering aid, Electrical Department, Illinois Central, has been appointed secretary of the recently combined Electrical Sections of the A.A.R. Engineering and Mechanical Divisions. Mr. Marras' headquarters will be in Chicago.

SUPPLY TRADE NOTES

TIMKEN ROLLER BEARING COMPANY—*Sherman R. Lyle* of the Cleveland office of Timken has been appointed district manager of the steel and tube division, northern Pennsylvania and New York state district. Mr. Lyle has been with Timken as sales engineer for the Cleveland district since 1946. His new office will be in Buffalo.

◆

HOUDAILLE-HERSHEY CORPORATION.—The *General Steel Castings Corporation*, Granite City, Ill., has been appointed sales representative for the Houdaille friction snubber on all applications of the snubber to railroad car trucks of G.S.C. manufacture. This snubber, designed by the *Chrysler Corporation*, is manufactured by the Houdaille-Hershey Corporation.

◆

ELASTIC-STOP NUT CORPORATION, AMERICAN GAS ACCUMULATOR COMPANY.—Stockholders of the Elastic Stop Nut Corporation of America and the American Gas Accumulator Company are holding special meetings this month to vote upon a proposed merger of the two companies. After the merger of A.G.A. into Elastic, the former's business would be carried on as a division of Elastic under present A.G.A. management.

◆

BABCOCK & WILCOX CO.—The Babcock & Wilcox Tube Co. has transferred its assets and business to the Babcock & Wilcox Co., its sole stockholder. The business continues to be operated as the tubular products division of Babcock & Wilcox.

◆

AMERICAN STEEL & WIRE CO.—*Fred L. Nonnenmacher* has been named manager of Chicago district sales of the *American Steel & Wire Co.*, subsidiary of U.S. Steel, succeeding *E. A. Murray*, resigned. Taking Mr. Nonnenmacher's place as manager of the manufacturers' products sales department in Chicago is *S. W. Goodenough*, while *R. H. Hauger* succeeds Mr. Goodenough as assistant mnager of mnufacturers' product sales, in Chicago.

◆

WHITING CORPORATION—*L. D. Reed*, executive engineer of the Whiting Corporation, Chicago, retired from active duty on November 30.

DEARBORN CHEMICAL COMPANY.—*Dr. Henry C. Rosenberg* has joined the research staff of the Dearborn Chemical Company, Toronto.

◆

JOSEPH T. RYERSON & SONS, INC.—Joseph T. Ryerson & Sons, Inc., has acquired the stocks and warehouse facilities formerly owned by the *Seattle Steel Company* and the *Inland Empire Steel Company*. Seattle Steel and Inland Empire Steel are in process of dissolution.

◆

AIR REDUCTION COMPANY.—*Joseph H. Humberstone* has been elected a vice-president of the Air Reduction Company. *Scott D. Baumer* succeeds Mr. Humberstone as president of the Airco Equipment Manufacturing division.

◆

JOHN A. ROEBLING'S SONS COMPANY. *Donald C. Hansen* has been named district sales representative for Ohio, Michigan and Western New York State, Woven Wire Fabrics Division.

◆

PENNSYLVANIA SALT MANUFACTURING COMPANY OF WASHINGTON—*Richard A. Snyder* has been appointed district sales manager for the Pennsylvania Salt Manufacturing Company of Washington. Mr. Snyder assumes the position of district sales manager of the industrial cleaners division and will head the Los Angeles sales office in the Westland Warehouse building. He was previously technical sales and service representative in Berkley, Cal.

◆

QUAKER RUBBER CORPORATION.—*J. R. Lewis*, assistant general sales manager, has been appointed general sales manager of the Quaker Rubber Corporation, Division of H. K. Porter Company, Philadelphia, succeeding *H. M. Sossaman* who has been elected vice-president in charge of commercial development.

◆

PITTSBURGH STEEL FOUNDRY CORPORATION—*Roy J. Heinz* has been elected vice-president of the Pittsburgh Steel Foundry Corporation in charge of operations at its Glassport, Pa., foundry. Mr. Heinz has been general foundry superintendent at Glassport for the past six years.

E. I. DU PONT DE NEMOURS & CO.—*Granville M. Fisher*, formerly transportation sales representative for the finishes division of E. I. du Pont de Nemours & Co. in the New York area, has been promoted to a supervisory position in the division's trade sales section. *J. David Lee*, formerly with the Philadelphia regional office, succeeds Mr. Fisher, with headquarters in New York.

◆

WESTINGHOUSE ELECTRIC CORPORATION—*H. H. Hanft* has been appointed assistant to the manager of the industrial department for the Westinghouse Electric Corporation. Mr. Hanft had been manager of the land transportation section.

◆

K. W. BATTERY COMPANY.—The K. W. Battery Company has announced completion and occupancy of a new $500,000 manufacturing plant, research laboratory and executive offices at 3555 Howard street, Skokie, Ill.

◆

PRESSED STEEL CAR COMPANY.—*William W. Greenway* has been appointed general manager of the Chicago steel tank division of Pressed Steel Car Company, with headquarters in Chicago. Mr. Greenway was formerly manager of the company's Rice & Adams equipment division in Buffalo, N. Y.

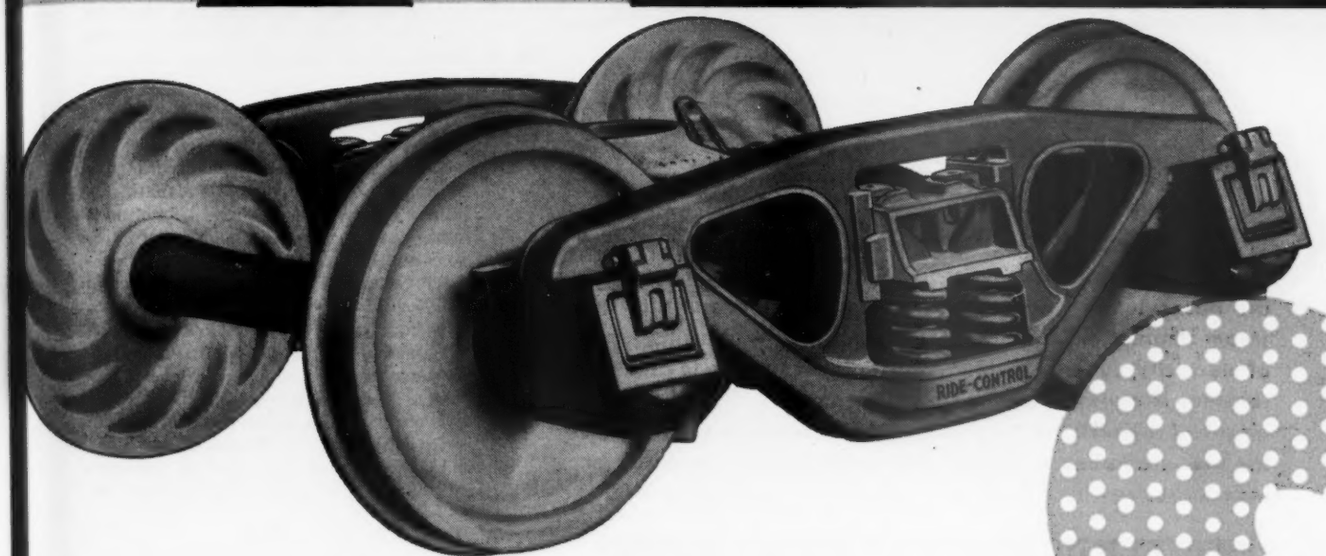
◆

FARREL-BIRMINGHAM COMPANY. — The Farrel-Birmingham Company, Ansonia, Conn., has acquired the common stock of the *Consolidated Machine Tool Corporation*, Rochester, N. Y., part of the consideration being Farrel-Birmingham securities. The Consolidated plant will be operated as a subsidiary of Farrel-Birmingham and will continue production of its machine tool lines. *Arthur H. Ingle* will remain as president of Consolidated and will be a director of Farrell-Birmingham.

◆

GENERAL ELECTRIC COMPANY—*W. J. Walker*, a member of the sales manager's staff of the locomotive and car equipment department of the General Electric Company, at Erie, Pa., has retired after 45 years of service with the company. Mr. Walker joined G.E.'s test program in 1906 and the

DESIGNED...DEVELOPED and PROVED by American Steel Foundries



With pardonable pride we remind railroaders that ASF was responsible for the development of the Ride-Control freight car truck. Its achievements in the field have been very gratifying during these last eight years.

Today, almost 300,000 ASF Ride-Control Trucks are in operation with 174 railroads and car owners. These trucks are delivering smoother, load-protecting, road-protecting rides in a wide variety of regular and high-speed freight train and box-express services. What are the reasons for such acceptance?

The Ride-Control Truck brought to railroading two great, necessary improvements: 1) It allowed the use of long-travel springs that give soft, impact-absorbing protection to lading. Even when a car is carrying its maximum permissible rail load, there is enough *reserve* spring travel to meet the needs of modern high-speed operation. 2) It provided proper and *constant* spring-action control to prevent harmful oscillation.

Engineeringwise, greatest of all accomplishments is the *utter simplicity* of the four little friction shoes which provide that control!

If you would like to know just how the Ride-Control Truck functions, please write for our booklet, "Quick Facts II." It's yours for the asking!

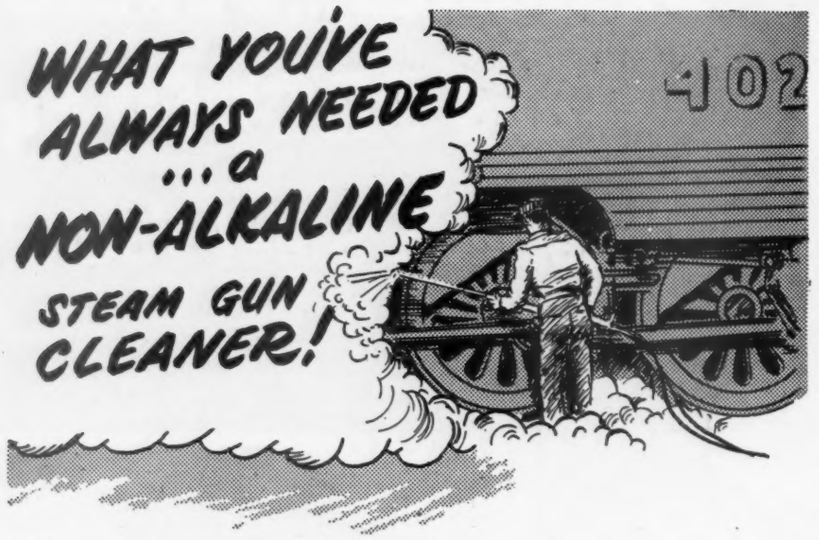
AMERICAN STEEL FOUNDRIES

410 N. Michigan Avenue, Chicago 11, Illinois

Mint Mark of ○ *Fine Products*

Canadian Sales: International Equipment Co., Ltd., Montreal 1, Quebec

Ride-Control Trucks



You make good use of the steam gun method of removing greasy, oily dirt in many railroad maintenance operations. But there has always been a handicap in using this method of cleaning. The alkaline salts on which conventional cleaners are based tend to clog lines, nozzles and other parts of the steam cleaning equipment. These alkaline salts are conductors of electricity, so that the danger of short circuits due to alkaline residues is always present when this method is used around electrical connections. And, of course, the fumes resulting from the use of alkaline steam cleaners make them impractical for indoor use.

TRY OUT THIS NEW CLEANER

Magnus 72 is a new and unique steam cleaning material that is completely non-alkaline and is neutral in reaction. It is non-conducting, non-clogging, non-corrosive and non-fuming. It can be used indoors just as readily as outdoors. And it is completely safe for operators. It will not attack painted surfaces.

Ask about our **TRIAL OFFER!**

You have the steam gun or vapor cleaning equipment. All you need is a supply of Magnus 72 to prove to your own satisfaction that you can now use a completely safe, speedy and economical cleaner that will cut your costs by a considerable margin. We're ready to send you an ample sample for such a tryout on a basis involving no obligation on your part. Write us for details.

Railroad Division

MAGNUS CHEMICAL COMPANY • 77 South Ave., Garwood, N. J.

In Canada—Magnus Chemicals, Ltd., Montreal

Magnus CLEANERS AND CLEANING EQUIPMENT

Representatives in all principal cities

transportation division in 1912. In January 1924, he transferred to the railway supply and renewal parts division and in 1931 became appointed manager of that division. He was appointed to the sales manager's staff in October 1947.

◆

YALE & TOWNE MANUFACTURING CO.—*James H. W. Conklin* has been appointed general sales manager of the Philadelphia division of the Yale & Towne Manufacturing Co. to succeed *James P. Kinney*, who is taking over the company's distributorship in Los Angeles and southern California.

Immediately before his present appointment, Mr. Conklin was with the sales department of the Pangborn Corporation, Hagerstown, Md., and prior to that, he was sales manager of the industrial truck division of the Clark Equipment Company.

◆

LUNKENHEIMER COMPANY.—Under a general reorganization of sales territories and executive appointments announced by the Lunkenheimer Company, Cincinnati, the United States will be divided into three Lunkenheimer sales areas—an Eastern division, under *Melvin W. Pauly*, sales manager; Central division, headed by *Harold H. Layritz*, sales manager; and Western division, directed by *Charles W. Burrage*, sales manager. *R. J. Sardieck*, with headquarters in Philadelphia, has been appointed district manager in the Eastern division; *E. R. Tieberman*, in Dallas, Tex., is district manager in the Central division; and *C. B. Rosser, Jr.*, district manager, will head the Western division, from Los Angeles.

◆

FLEXROCK COMPANY.—The mechanical rod packing and building maintenance divisions of the Flexrock Company have announced appointment of *Hinds & Associates, Inc.*, of Kansas City as their exclusive representative in Kansas, Nebraska, Oklahoma, Arkansas and western Missouri.

◆

BAKER-RAULANG COMPANY.—*G. B. Davis*, formerly sales manager of the Baker-Raulang Company, has been elected vice-president in charge of sales, to replace *John R. Morrill*, recently resigned.

◆

GRAYBAR ELECTRIC COMPANY.—*S. M. Lawrason* has been apointed manager of the Baton Rouge, La., branch of the Graybar Electric Company. Mr. Lawrason formerly was sales manager of the branch, which was opened early in 1951.

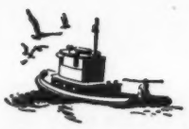
◆

GOULD-NATIONAL BATTERIES, INC.—*Willard C. Shull* has been appointed special special assistant to the president. Mr. Shull joined Gould-National in 1937 and for the past two years has been assistant general sales manager, brand sales.

◆

GENERAL STEEL CASTINGS CORPORATION.—*Pierre O. Wood* has been appointed manager of service at Granite City, Ill., succeeding *W. J. Taylor*, retired. A bio-

they're custom-built to fit the job!



Work boats, pleasure craft

Drilling rigs, centrifugal pumps, generator sets

Earthmovers, logging yarders and loaders

Buses and highway trucks

Off-highway trucks, crawler tractors

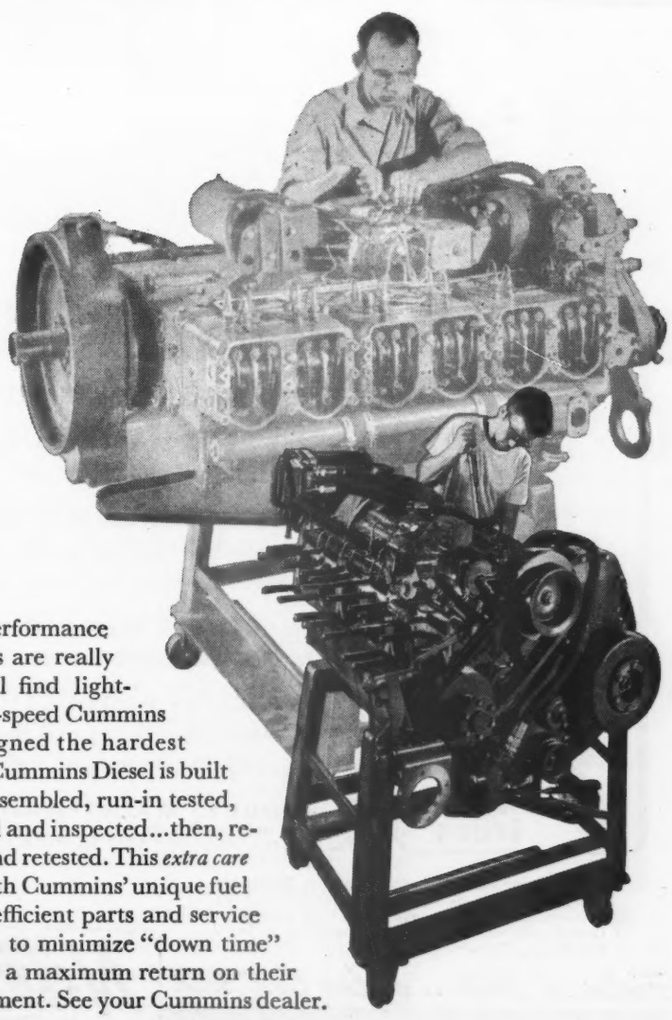
Shovels, cranes, industrial locomotives and switchers

Lightweight, high-speed Diesels (50-550 hp) for these and many other uses

Cummins® Diesels do so many jobs so much better

they're

BUILT NOT ONCE BUT TWICE



Wherever performance requirements are really rough, you'll find lightweight, high-speed Cummins Diesels assigned the hardest jobs. Every Cummins Diesel is built *TWICE*—assembled, run-in tested, disassembled and inspected...then, reassembled and retested. This *extra care* combines with Cummins' unique fuel system and efficient parts and service organization to minimize "down time" ...give users a maximum return on their diesel investment. See your Cummins dealer.

CUMMINS Dependable DIESEL

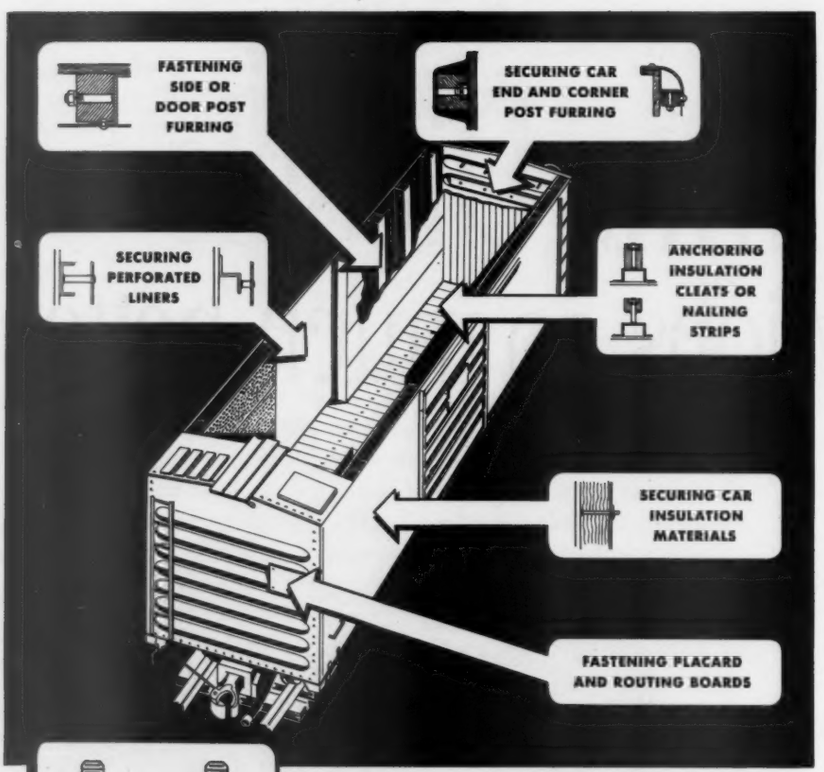
TRADEMARK REG. U.S. PAT. OFF.

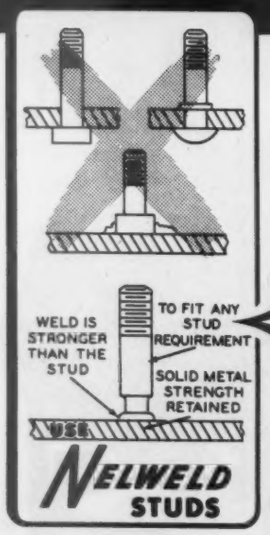
Diesel power by CUMMINS

CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA

Export: Cummins Diesel Export Corporation • Columbus, Indiana, U.S.A. • Cable: Cumdiex

Cut fastening costs on CAR BUILDING AND REPAIR with NELWELD


FASTENING SIDE OR DOOR POST FURRING
SECURING CAR END AND CORNER POST FURRING
SECURING PERFORATED LINERS
ANCHORING INSULATION CLEATS OR NAILING STRIPS
SECURING CAR INSULATION MATERIALS
FASTENING PLACARD AND ROUTING BOARDS



GET THESE ADVANTAGES WITH NELWELD STUDS:

REDUCES MATERIAL HANDLING
by taking the tool to the job

INSURES WATERTIGHT FASTENINGS
no holes for moisture penetration — smooth exterior surfaces

INCREASES MEMBER STRENGTH
by eliminating punched holes

INCREASES PRODUCTION SPEEDS
by eliminating drilling and reaming, punching, stud-riveting or hand welding

REDUCES MAINTENANCE COSTS
... no bolts or rivets to work loose

Full information and Nelweld Engineering Service are available to show you how these advantages can bring cost-saving results to your fastening operations. Contact your nearest Nelson representative or Dept. R-3, Lorain, Ohio.

Fasten it Better... at Less Cost, with NELWELD

NELSON STUD WELDING

DIVISION OF GREGORY INDUSTRIES, INC., LORAIN, OHIO

graphical sketch and photograph of Mr. Wood appeared in the May 1951 issue page 102, at the time he became assistant manager of service.

◆

AMERICAN CAR & FOUNDRY CO.— *Norman E. Carlson*, has been appointed assistant chief mechanical engineer of the American Car & Foundry Co., with headquarters in New York. Mr. Carlson became associated with the company after eight years service

N. E. Carlson

with the Great Northern. He served in automotive engineering work with Swift & Co. in South St. Paul and Chicago from 1933 to 1939, when he became operations manager of Greyvan Lines in Chicago. In 1943 he became assistant master carbuilder in the mechanical department of the G.N.

◆

TAYLOR FIBRE COMPANY.—*Harold C. Steadman*, general manager of the Taylor Fibre Company, has been elected vice-president.

◆

STANDARD RAILWAY EQUIPMENT MANUFACTURING COMPANY. — *Dean C. Webster* has been appointed assistant vice-president, with headquarters in New York. Mr. Webster, who has been assistant chief engineer since he joined Standard Railway in 1946, will have responsibility in Eastern and Southeastern districts for all mechanical and engineering matters dealing with Standard and its customers and per

D. C. Webster

Read the facts about

AIRCO's NEW NO. 20 RADIAGRAPH

Up-to-the-minute in design, the No. 20 Radiagraph is Airco's newest service-proven portable gas cutting machine.

. . . So you'll know about the first gas-cutting machine designed to carry Aircomatic®, Heliwelding, Flame Hardening, and other *fabrication* equipment . . .

. . . So you'll be among the first to know how the No. 20 Radiagraph cuts circles and arcs, any length straight lines, simultaneous parallel lines — with single or double bevels, and irregular shapes.

. . . So you'll know how this 57-lb. one-man portable can be put to work for you, we've written up all the detailed information you need in a quick-reading, 8-page folder. To get your copy of the No. 20 Radiagraph catalog, please fill in the attached coupon and mail it to us today, or write us on your business letterhead.

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REPRESENTED INTERNATIONALLY BY AIRCO COMPANY INTERNATIONAL
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AT THE FRONTIERS OF PROGRESS YOU'LL FIND

AN AIR REDUCTION PRODUCT

Air Reduction Sales Company
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Gentlemen:

Send me the No. 20 Radiagraph catalog today.

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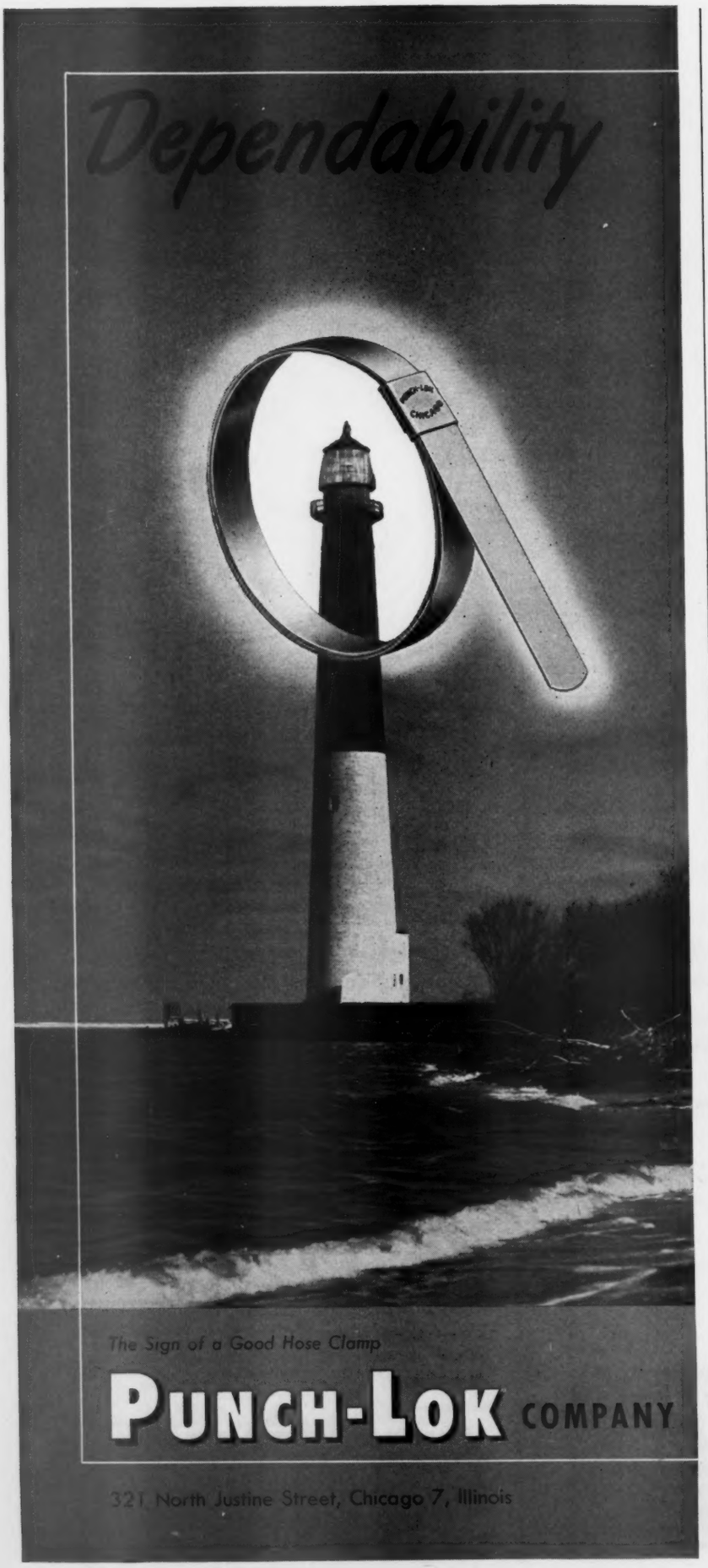


form other duties assigned by the vice-president in charge of sales.

◆

WILLIAM F. CLAPP LABORATORIES, INC.—*A. P. Richards* has been elected president and director of the William F. Clapp Laboratories, Inc., Duxbury, Mass., to succeed *Dr. William F. Clapp*, deceased.

◆

FENWALL, INC.—*Joseph P. Maguire* has been appointed sales representative of Fenwal, Inc. for Louisiana. Mr. Maguire's offices are at 208-209 Vincent building, 615 Commercial place, New Orleans.

◆

BUFFALO FORGE COMPANY.—*Theodore M. Dillaway* and *George B. Kellogg* have been appointed assistant vice-presidents of the Buffalo Forge Company.

Obituary

HOWARD MULL, vice-president of sales at Chicago of the Warren Tool Corporation, Warren, Ohio, died on December 22.

HARRY M. PFLAGER, director and former senior vice-president of General Steel Castings Corporation, died recently at St. Louis.

WILLIAM A. IRVIN, former president of the United States Steel Corporation, died in New York on January 1, at the age of 78. Mr. Irvin was a director and a member of the finance committee of United States Steel.

HENRY NOTT RANSOM, vice-president of the Waugh Equipment Company, died on December 26, 1951, in St. Clare's Hospital, New York. Mr. Ransom was born in Gordonville, N. Y., on August 19, 1870, and was educated at the Albany Boys Academy. At various times in his career, Mr. Ransom was connected with the sales departments of the Consolidated Car Heating Company, the Christinson Air Brake Company, the General Electric Company and the Westinghouse Electric & Manufacturing Co., and was purchasing agent for the International Railway. He was with Waugh Equipment for more than 30 years.

DR. WILLIAM F. CLAPP, president and director of the William F. Clapp Laboratories, Inc., Duxbury, Mass., died on December 28.

HERBERT I. DUNPHY, assistant vice-president of the American Car & Foundry Co., died on January 23 after a brief illness.

PERSONAL MENTION

General

William H. Gimson, superintendent of motive power of the St. Louis-San Francisco at Springfield, Mo., has been appointed chief mechanical officer at Springfield. Mr. Gimson, who was born on September 13, 1887, at Memphis, Tenn.,

STANDARD ENGINEER'S REPORT

DATA

LUBRICANT RPM Delo Oil R.R.

UNIT Diesel Locomotive cylinder assembly

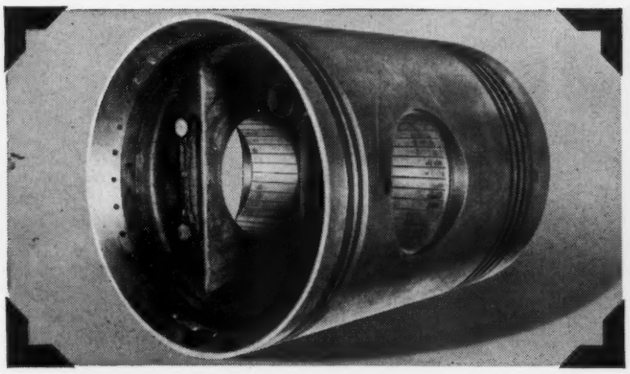
SERVICE Mountain Freight

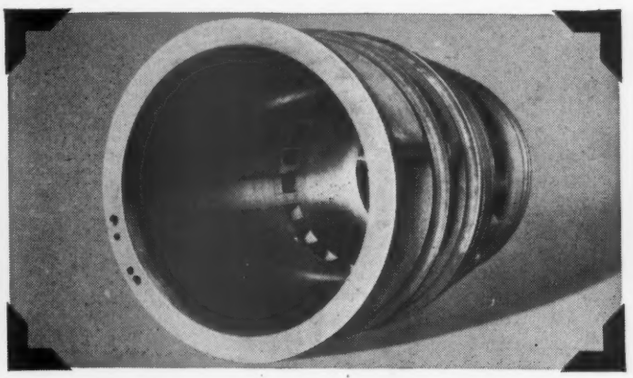
LOCATION Transcontinental freight service on Moffat tunnel & Royal Gorge Routes

PERIOD In excess of 8 years

FIRM Denver & Rio Grande Western R.R.Co.

One million miles of service on cylinder liners and pistons





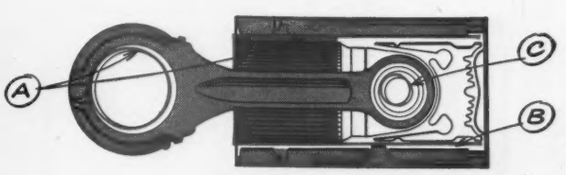
IN SERVICE APPROXIMATELY 1,000,000 MILES in Denver & Rio Grande Western Railroad diesel locomotive engines, this piston and cylinder liner were always lubricated with RPM DELO Oil R.R. At the end of that time wear measurements (inches) were only: Piston Skirt—0.001; Ring Grooves—No. 1—0.003 to 0.006, No. 2—0.002, No. 3 & 4—none; Cylinder liner (maximum diameter)—0.0095, (out of round)—0.002 to 0.004.

RPM DELO Oil R.R. has been the standard on the Denver & Rio Grande Western Railroad for over-the-road freight and passenger locomotives since their first power of this type was placed in service in January 1942. At the time this inspection was made approximately 49,563,104 miles had been traversed by the Rio Grande freight diesel fleet of 100 units and during that period only 77 cylinder liners had been scrapped for any reason. At that time many of the original pistons and cylinder liners were still in service and the average age of all these assemblies, including recently purchased power, was 4.7 years.

RPM DELO LUBRICATING OILS

TRADEMARK "RPM" REG. U.S. PAT. OFF.

How RPM DELO Oil R. R. prevents wear, corrosion, oxidation



A. Special additive provides metal-adhesion qualities...keeps oil on parts whether hot or cold, running or idle.

B. Anti-oxidant resists deterioration of oil and formation of lacquer...prevents ring-sticking. Detergent keeps parts clean... helps prevent scuffing of cylinder walls.

C. Special compounds stop corrosion of any bushings or bearing metals and foaming in crankcase.

FOR MORE INFORMATION about this or other petroleum products of any kind, or the name of your nearest distributor handling them, write or call any of the companies listed below.

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street • San Francisco 20, California

THE CALIFORNIA COMPANY
P. O. Box 780 • Denver 1, Colorado

STANDARD OIL COMPANY OF TEXAS
P. O. Box 862 • El Paso, Texas

9 DAYS' FABRICATION IN 1/2 DAY with this "Buffalo" U.I.W.

With their No. ½ "Buffalo" UNIVERSAL IRON WORKER*, a well-known electrical manufacturer accomplishes in just a half-day fabrication operations which formerly required nine days! Similar astonishing time savings are being affected throughout the metal working industries with these versatile punching-shearing-bar cutting-mitring-coping-notching machines. Top photo shows two operations going on at once: (1) man on left is punching holes in the leg of an angle and (2) man at right is coping an angle.

Right, ANGLE MITRE is just one of many jobs the U.I.W. handles. Just below angle stripper is stripper for round and square bars, always in position. For complete information on the seven models available, write for Bulletin 322-0.

Left, the U. I. W. PUNCHING AND SHEARING SIMULTANEOUSLY. Note stripper at shear end holding flat tightly against bottom knife. Easy maintenance is assured by centralized oiling systems.

"Buffalo" MACHINE TOOLS

BUFFALO FORGE COMPANY

174 Mortimer St. Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

DRILLING PUNCHING CUTTING SHEARING BENDING

became a machinist apprentice on the Frisco at Memphis in September 1904. He was later enginehouse foreman and on

W. H. Gimson

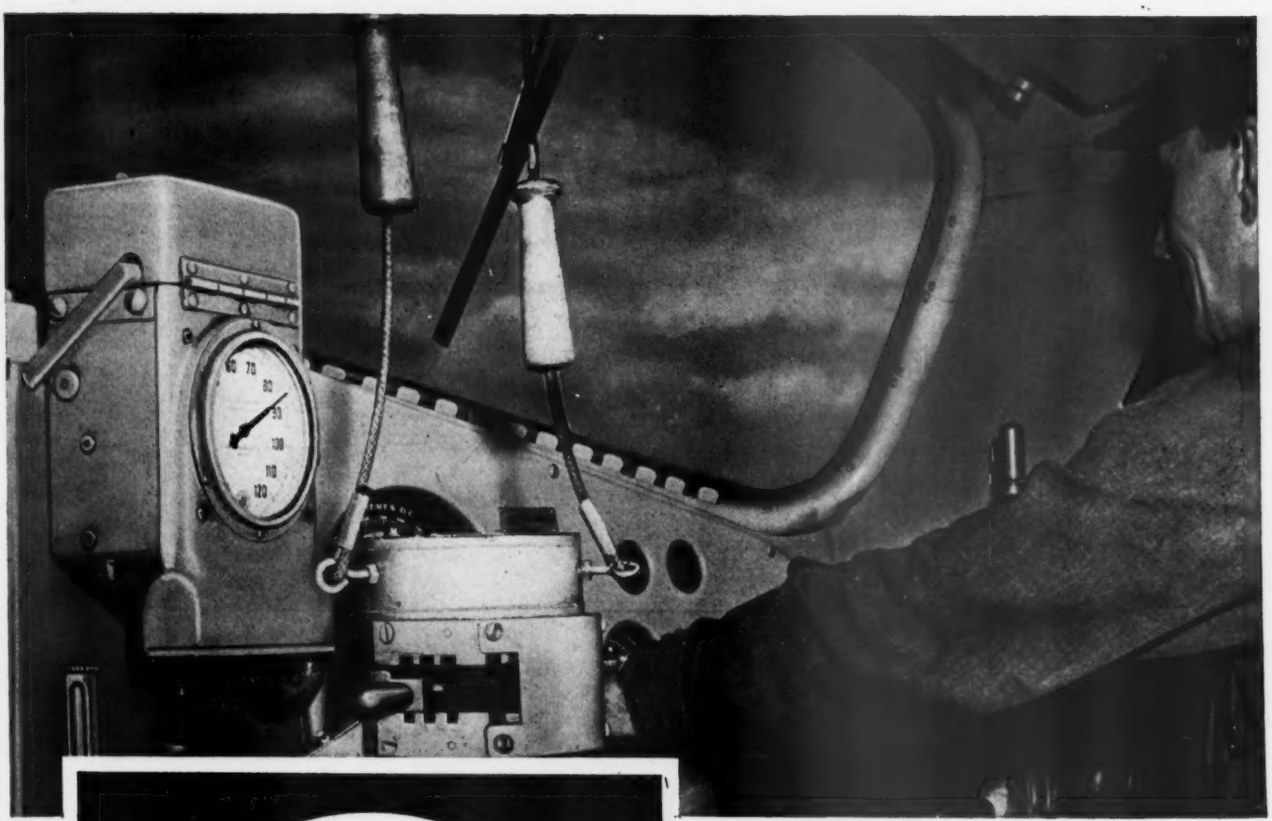
March 1, 1917, became division foreman at Harvard, Ark. He subsequently served at Monett, Mo., as general foreman and on August 15, 1929, was appointed shop superintendent at Tulsa, Okla. He became master mechanic at Tulsa on January 1, 1941; assistant superintendent motive power at Springfield in October 1945, and superintendent motive power in May 1947.

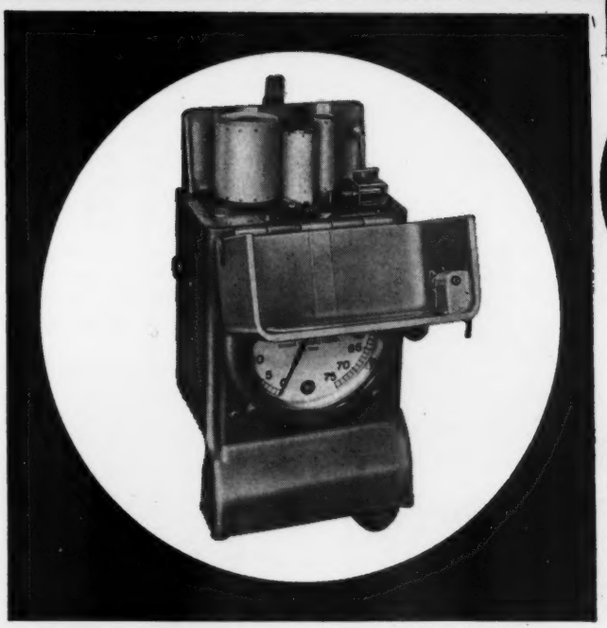
W. B. BERRY, chief mechanical officer of the St. Louis-San Francisco, at Springfield, Mo., has retired. Mr. Berry was born on December 13, 1881, at St. Louis. He attended Austin College at Sherman, Tex., and served in the Spanish-American War before starting his railroad career in 1899 as a machinist-apprentice with the Texas & Pacific. Subsequently as a machinist he worked for a number of railroads, joining

W. B. Berry

the Frisco in 1907 at Sherman, Tex. After serving as enginehouse foreman at Monett, Mo., and Ft. Worth, Tex., Mr. Berry became enginehouse and general foreman at Springfield in 1919. In 1922 he was transferred to Kansas City as master mechanic. In 1935 he was appointed assistant superintendent of motive power at Springfield; in 1945 superintendent of motive power, and in 1948 chief mechanical officer.

HARRISON L. PRICE, superintendent of shops of the Atchinson, Topeka & Santa Fe





Top of Recorder opened to show recording tape.

Gives detailed record

CP SPEED RECORDER

provides accurate and permanent record of —

Locomotive Running Speed
Distance Traveled
Acceleration
Deceleration
Forward or Backward Movement
Slippage or Sliding of Wheels

Available in two speed ranges: High Speed Recorder (CP-120-MR) for 10 to 120 miles an hour operation: Low Speed Recorder (CP-75-MR) for 0 to 75 miles an hour operation. Also furnished in kilometer models.

CP Speed Indicators, identical in construction with the Recorders, except for the recording mechanism, are also made in High and Low Speed models (CP-120-MI and CP-75-MI).

Write for a copy of Bulletin 841-2

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PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
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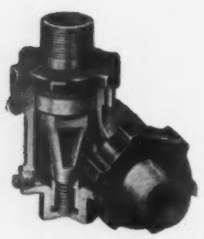
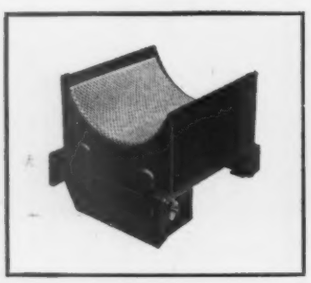
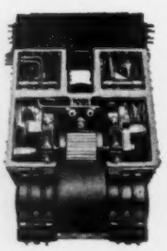
In order to obtain full efficiency from your Franklin devices, specify genuine Franklin parts in replacement. Franklin devices will always perform best when equipped with genuine Franklin parts made to interchangeable tolerances and of the correct materials.



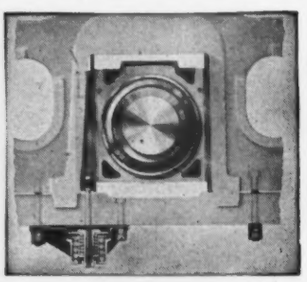
Sleeve Joints



Driving Box Lubricators

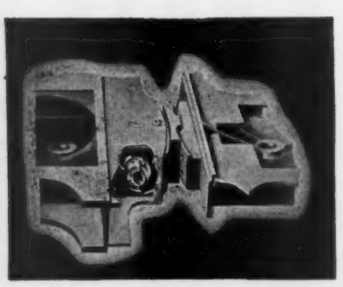


The Locomotive Booster



Automatic Compensators & Snubbers

Franklin System of Steam Distribution



Radial Buffers

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Power Reverse Gears

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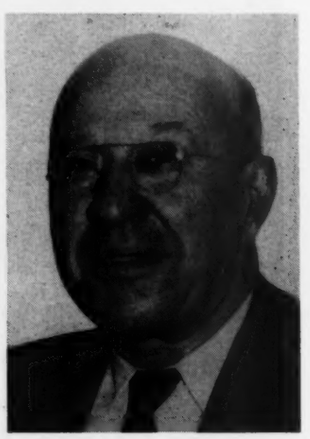
EXCLUSIVE RAILWAY DISTRIBUTORS FOR: N.A. STRAND FLEXIBLE SHAFT EQUIPMENT
IRVINGTON ELECTRICAL INSULATION AND VARNISH

at Albuquerque, N. M., has been appointed mechanical assistant, with headquarters in Chicago. Mr. Price entered Santa Fe service as a machinist apprentice at Topeka, Kan., in 1916. He worked successively as clerk, machinist, engine inspector, apprentice instructor, welder, test department assistant, car gang foreman, air-brake foreman, and acting superintendent of Chicago car works until 1941 when he was appointed superintendent Chicago car works. He was appointed master mechanic at Chanute, Kan., in 1943, and in April of that year transferred to Chicago. In 1949 he became superintendent of shops at Albuquerque.

H. L. Price

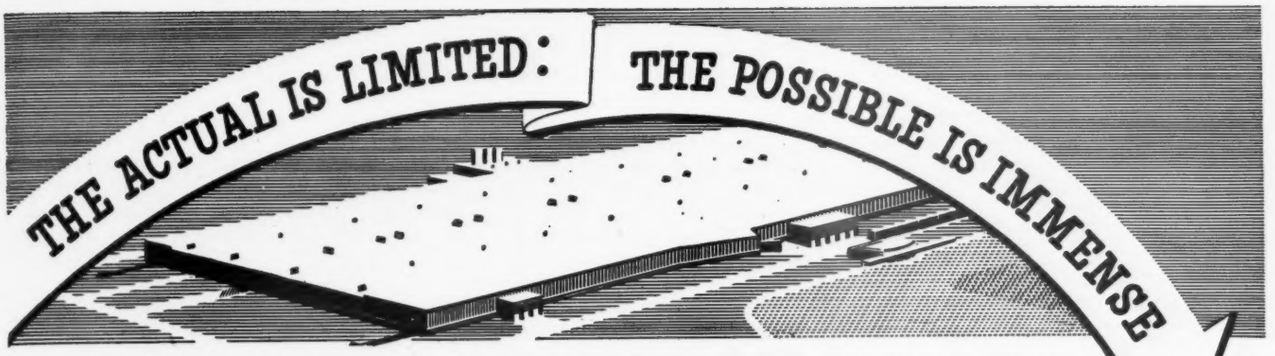
RALPH D. BRYAN, mechanical assistant of the Atchison, Topeka & Santa Fe at Chicago, has retired. Mr. Bryan entered Santa Fe service in 1905 at Argentine, Kan. He served as a laborer, appointed car clerk, bonus clerk and assistant car foreman until 1915 when he became general car foreman at Arkansas City, Kan.



R. D. Bryan

He later served in various other positions until 1937 when he was appointed assistant superintendent of the car department at San Bernardino, Cal. In 1939 he was transferred to Topeka as acting engineer of car construction. Mr. Bryan was appointed engineer car construction at Topeka in 1942 and later in that year became mechanical assistant.

(*Continued on page 128*)



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

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SPEEDS CONSTRUCTION . . . CUTS MAINTENANCE COSTS

WELDING speeds, *up to 300% faster than with hand welding,* are being achieved with Automatic and Manual "Lincolnwelding". At the same time, deeper penetration and greatly simplified welding procedures are assuring top quality welds conforming to A.A.R. standards with a minimum of supervision. The net results are more work with fewer man-hours and less cost. On conventional maintenance, hand welding with Lincoln's "Shield-Arc," "Fleetweld" team is speeding repair work with faster, easier welding in all positions, according to reports.

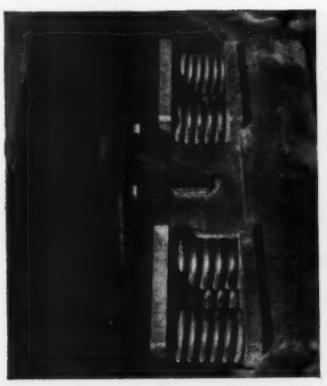


Fig. 5 Fabricated Trucks *for diesel locomotive. Components are flame cut from steel plate and fillet welded into a single, rugged assembly.*

Fig. 4 Reclaims Center Plate Castings *by building up surfaces with Lincoln "Fleetweld" 5.*

Fig. 3 Replaces Center Plate *on diesel locomotive. Old plate is cut out, ring is fillet welded to new plate, in flat position. Ring assembly is then fitted overhead to frame, and fillet welded with "Fleetweld" 5.*

ARC WELDING SAVES MAN-HOURS AND CUTS COSTS ...ALL WAYS

Fig. 1 "Manual Lincolnwelding" *center sill reinforcement. Welding speed is 20 inches per minute.*

Fig. 2 "Automatic Lincolnwelding" *of center sill Z-bars in the production of freight cars. Welding speed is 40 inches per minute.*

HERE'S MORE PROOF

For further information about arc welding procedures and equipment, write The Lincoln Electric Railway Sales Co., 11 Public Square, Cleveland 13, Ohio. Railroad representatives of

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 17, OHIO

(Continued from page 124)

ARTHUR SELBEE, superintendent of motive power and car equipment of the Central Vermont at St. Albans, Vt., has been appointed general superintendent of motive power and car equipment of the Grand Trunk Western, with headquarters at Battle Creek, Mich.

W. C. SEALY, who has retired as general superintendent motive power and car equipment, Central Region, of the Canadian National at Toronto, as announced in the January issue became a messenger in the shops of the C.N.R. at Stratford, Ont., in May 1903. In 1904 he became an apprentice mechanic and in 1909, erecting shop foreman at Stratford. Between 1910 and 1915 he was, successively, general foreman and assistant master mechanic at Toronto. In the latter year he was appointed master mechanic and served until 1917 when he was loaned to the General Car & Machinery Co., Montmagny, Que., as an instructor in the installation of a shell manufacturing plant. He returned to the C.N.R. in the same year as a foreman in the Stratford shop which was then engaged in the manufacture of shells for the British army. Mr. Sealy was appointed general foreman at Stratford in 1921, and from October 1928 to January 1929 was acting superintendent motive power. He then became superintendent motive power. He was named general superintendent motive power and car equipment at Toronto in October 1942.

E. F. TUCK, assistant superintendent of motive power of the St. Louis-San Francisco at Springfield, Mo., has been appointed superintendent of motive power at Springfield. A sketch and photograph of Mr. Tuck appeared on page 154 of the November, 1951, issue at the time of his appointment to the position of assistant superintendent of motive power.

E. F. Tuck

Car Department

C. A. GAMMON, general car foreman of the Miller shops of the Florida East Coast at St. Augustine, Fla., has been appointed to the newly created position of superintendent car department. The position of master car builder has been abolished.

C. A. Gammon

Mr. Gammon was born at Cedar Rapids, Iowa, on January 26, 1896, and entered railroad service with the New York, Chicago & St. Louis at Stony Island shops, Chicago, as stock clerk in the stores department. He later transferred to the mechanical department as wheel checker, air brake apprentice and A.A.R. checker. He was with the Illinois Central in the A.A.R. billing department at Chicago until No-

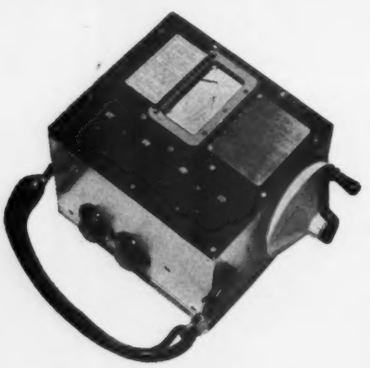
BIDDLE *Instrument News*

TWO HELPFUL INSTRUMENTS FOR RAILROAD ELECTRICAL MEN

NEW MEGGER®

Low Resistance Ohmmeter

Single unit, general purpose instrument with self-contained power supply. Available in two models: Model 1B carries batteries and Model 1R has a built-in rectifier which plugs into any ordinary lighting circuit outlet. Both have same ranges of 0 to 1000 and 0 to 10,000 microhms. Weight of complete unit with either batteries or rectifier is about 19 lbs. There is ample space in the case for storage of all necessary leads and prods. Designed for compactness and easy portability, this instrument is most convenient for field use. Write for complete description given in Bulletin 24-46-X.



BRIDGE-MEG®

Insulation and Resistance Testers

These instruments provide you with nearly everything you need for electrical resistance measurements from a fraction of an ohm up to 1000 megohms. In one unit weighing about 15 lbs. you have a Megger® direct reading ohmmeter for measuring insulation resistance, and a Wheatstone Bridge for measuring conductor resistance of coils, resistors and circuits. A Varley Loop feature for locating faults on wires may also be included.

The Bridge-Meg requires no batteries or outside source of current. Test current is supplied by a hand-cranked generator. Its constant-voltage mechanism eliminates the "human element" in the speed of turning the crank. Available complete with carrying case and test record cards in a standard selection of 5 ohmmeter scales. Write for 12-page Bulletin 21-60-X.

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• SPEED MEASURING INSTRUMENTS
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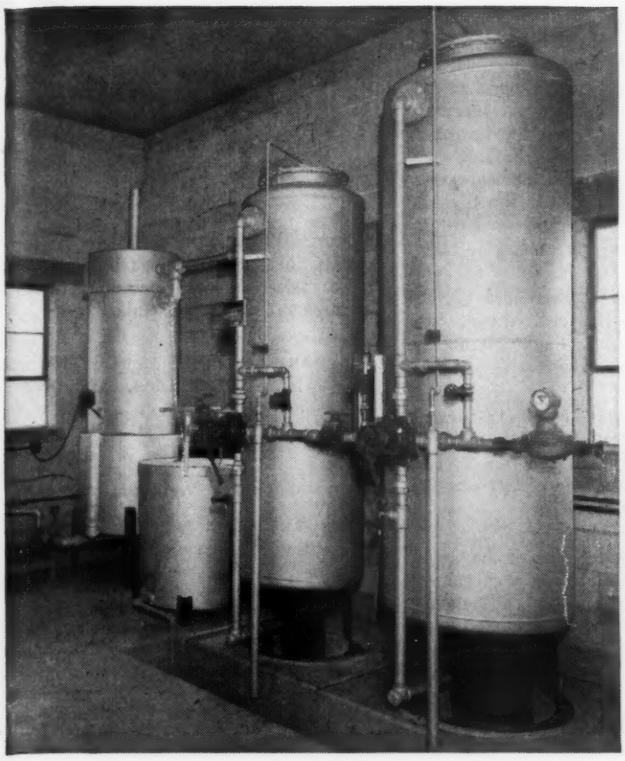
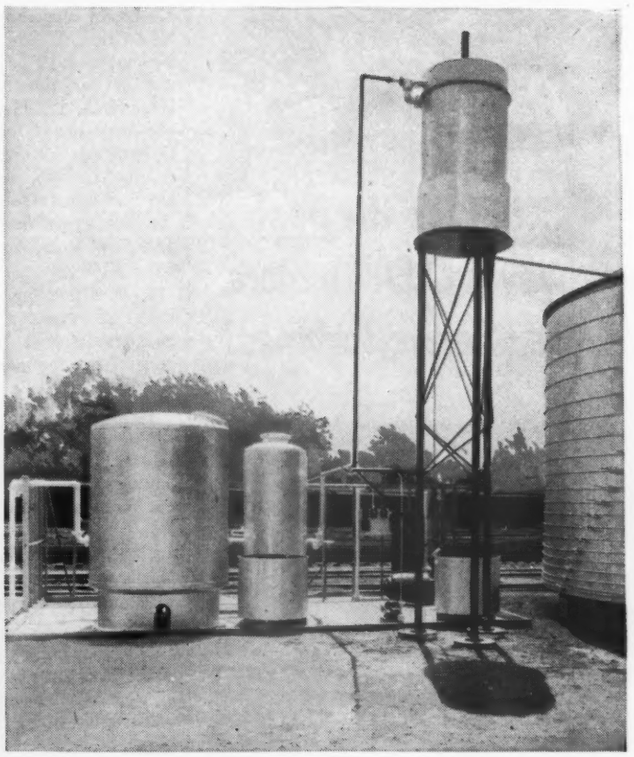


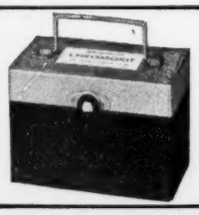


A DEARBORN DE-IONIZING SYSTEM TO MEET THE COMPLETE NEEDS OF YOUR RAILROAD

A Dearborn De-Ionizing system will provide the mineral-free water you need at less than 10 percent the cost of distilled water.

This mineral-free water, when conditioned with Dearborn formula 517, will provide proper Diesel cooling . . . eliminate mechanical failure of liners, heads and blocks caused by corrosion, scale and sludge deposits. This combination will protect cooling systems of engine-driven auxiliary generators and radiators of trucks, buses, scrapers, graders, caterpillars. Dearborn De-Ionizing systems will also produce mineral-free water for storage batteries and adequate supplies of scale-free, non-corrosive water for Diesel steam generators.

A Dearborn engineer will discuss a De-Ionizing system to meet the requirements of your operation. The only information required is: (1) Analysis (or sample) of raw water; (2) quantity and quality of mineral-free water required; (3) available space for equipment; (4) raw water pressure and size of supply line; (5) available power characteristics.



HAVE YOU REQUISITIONED YOUR DEARBORN CHROMOKIT?

It provides a fast, simple, accurate and economical way to determine the chromate content of your Diesel cooling water. Only $7.50 each.

INFORMATION ON DE-IONIZING SYSTEMS

A copy of "Dearborn De-Ionizing Systems," containing valuable information about how to secure the mineral-free water you need, will be sent upon request.

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( ) Please send booklet "Dearborn De-Ionizing Systems"
( ) Have a Dearborn Engineer call.

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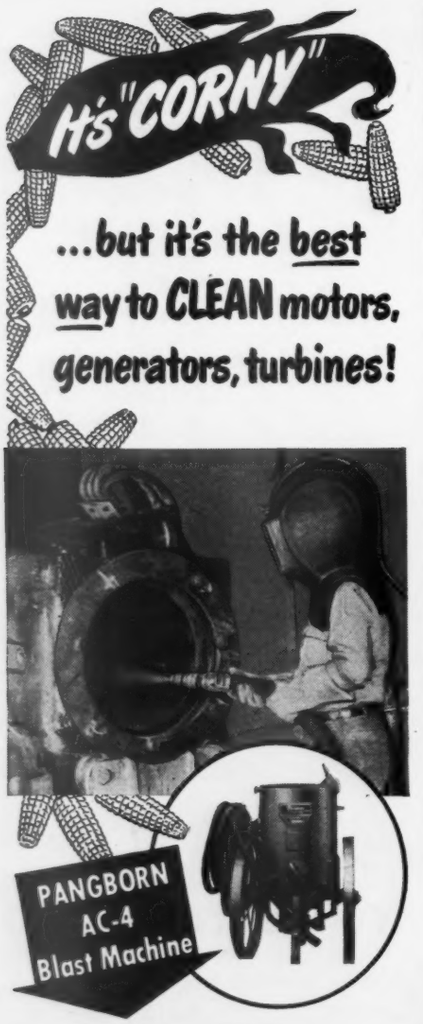

- CUTS DOWN-TIME
- CLEANS WITHOUT SOLVENTS
- ELIMINATES DRYING
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THE new Pangborn AC-4 Blast Machine cleans motors, generators and turbines faster . . . cleaner . . . and lets you use them sooner because there's no waiting for parts to dry. In fact, dangerous solvents that can lead to explosions, caustic action, and toxic poisoning are completely eliminated!

The AC-4 uses soft, 20-mesh corncob grits to rapidly remove dirt, grease, old paint, etc., in one-third the time, and at 90% less cost than old-fashioned methods. GET FULL DETAILS . . . write, telling us what you clean, to: PANGBORN CORP., 3700 Pangborn Boulevard, Hagerstown, Md.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment

Pangborn

BLAST CLEANS CHEAPER with the right equipment for every job

vember 17, 1917, when he became employed in the shops of the Louisville & Nashville at South Louisville, Ky. In November 1919 he became piece work inspector for the Ryan Car Company at Hegewisch, Ill. Mr. Gammon was general car inspector of the Missouri Pacific prior to entering the service of the F. E. C. on August 1, 1925, as general car inspector. He was appointed general car foreman of the Southern division at Miami on April 1, 1929, and at St. Augustine on July 1, 1931.

J. M. HICK, general car foreman of the Great Northern at Hillyard, Wash., has been transferred to St. Paul, Minn., as general car foreman.

HENRY G. HIELSCHER, chief car inspector of the Elgin, Joliet & Eastern, and not of the Illinois Central as reported in the January issue, has been appointed general car foreman at Gary, Ind.

N. E. WESTON, car foreman of the Great Northern at Havic, Mont., has been named assistant master car builder at Spokane, Wash.

O. R. DONOHO has been appointed general car foreman of the Florida East Coast at St. Augustine, Fla.

VICTOR SMALL, assistant superintendent of the car department of the Elgin, Joliet & Eastern, and not of the Illinois Central as reported in the January issue, has been appointed superintendent of the car department at Gary.

CLARENCE C. LARSON, general car foreman of the Elgin, Joliet & Eastern, and not of the Illinois Central as reported in the January issue, has been appointed assistant superintendent of car department at Gary, Ind.

HAROLD D. MCCONAHY, division car foreman of the Erie at Meadville, Pa., has been transferred to the position of division car foreman at Marion, Ohio.

RAYMOND KNORR, division car foreman of the Erie at Marion, Ohio, has retired.

Shop and Enginehouse

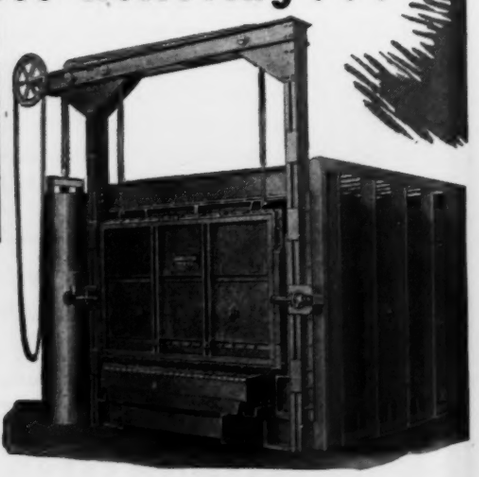
VERNON R. COWARD, general foreman of the Southern at Alexandria, Va., has been transferred to the position of general foreman at Hamburg, S. C.

OSCAR L. POND, assistant foreman enginehouse of the Southern at Greenboro, N. C., has been appointed general foreman at Lynchburg, Va.

SAMUEL E. BUTLER, foreman diesel locomotives of the Southern at Alexandria, Va., has been appointed general foreman at Alexandria.

For Efficient Annealing and Stress Relieving . . .

JOHNSTON CAR BOTTOM FURNACES



Engineering experience is apparent in the smooth mechanical operation of the Johnston Car Bottom Furnace. Roller bearings in car and door hoist shafts, and power operated car pullers are just a few of many practical features. Johnston "Reverse Blast" low pressure burners assure clean, economical, efficient heat for annealing, normalizing, and stress relieving.

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Over Thirty Years Experience in the Design and Manufacture of

Burners • Blowers • Furnaces • Rivet Forges
Fire Lighters • Tire Heaters • Allied Equipment

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ENGINEERS & MANUFACTURERS OF INDUSTRIAL HEATING EQUIPMENT

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Esso Andok Lubricants

better lubricants

for better protection

THE IDEAL LUBRICANT— for all traction motor armature bearings... it has successfully performed in many anti-friction bearings in auxiliary equipment on passenger cars and locomotives.

ANDOK LUBRICANT GIVES 3-WAY SERVICE *when properly used* for important traction motor armature bearings:

1. Avoids overgreasing.
2. Avoids undergreasing.
3. Helps prevent introduction of dirt into bearings.

Bearings lubricated with famous Andok Lubricant can be completely sealed after overhaul... should run under ordinary use for 400,000 miles without further attention. For high-quality, long-lasting lubrication protection that saves on maintenance costs... specify Andok Lubricant.

BACKED BY CONSTANT RESEARCH— continuing tests *in the lab* and *on the road* make certain that Andok Lubricant keeps pace with progress and latest railroad lubrication needs.

BACKED BY CONSTANT FOLLOW-UP— on-the-job check-ups by Esso Sales Engineers watch the dependable performance of Esso Railroad fuel and lubricants. Be sure to call on Esso for any railroad fuel or lubricating problems.

The Sign of QUALITY — ESSO — The Symbol of SERVICE

RAILROAD PRODUCTS

SOLD IN: Maine, N. H., Vt., Mass., R. I., Conn., N. Y., N. J., Penna., Del., Md., D. C., Va., W. Va., N. C., S. C., Tenn., Ark., La.

ESSO STANDARD OIL COMPANY — Boston, Mass. — New York, N. Y. — Elizabeth, N. J. — Philadelphia, Pa. — Baltimore, Md. — Richmond, Va. — Charleston, W. Va. — Charlotte, N. C. — Columbia, S. C. Memphis, Tenn. — New Orleans, La.

D. J. EVERETT, master mechanic of the Atchinson, Topeka & Santa Fe at Galveston, Tex., has been appointed superintendent of shops at Albuquerque, N. M.

HENRY A. M. WHITE, foreman of the wheel shop of the Great Northern at St. Paul, has been appointed superintendent of shops at Superior, Wis.

WILLIAM T. CURLEE, general foreman of the Southern at Strasburg, Va., has been appointed general foreman at Durham, N. C.

Diesel

J. W. LUKE, day diesel enginehouse foreman of the Atchison, Topeka & Santa Fe at Argentine, Kan., has been appointed general supervisor of diesel engines at Chicago.

G. R. WEAVER, master mechanic of the Maryland-Delmarva division of the Pennsylvania at Wilmington, Del., has been appointed superintendent motive power—diesel of the Central region at Pittsburgh. Mr. Weaver was born at Huntingdon, Pa. He attended Juniata College for three years, and is a graduate of Purdue Universite (1931). He entered the employ of the Pennsylvania as a laborer on the Middle division in 1929. Following service as a car builder, foreman and assistant master mechanic, he was promoted to master mechanic on the Eastern division early in 1949. He was transferred to the Delmarva division on November 1, 1949.

Master Mechanics and Road Foremen

L. L. LUTHEY, general supervisor of diesel engines of the Atchison, Topeka & Santa Fe at Chicago, has been appointed master mechanic at Galveston, Tex.

F. J. FELLENZER, road foreman of engines, Dakota division, of the Chicago & North Western at Tracy, Minn., has retired.

W. G. HALL, master mechanic of the St. Louis-San Francisco at Kansas City, has retired.

A. R. MARSH, master mechanic of the Susquehanna division of the Pennsylvania at Williamsport, Pa., has been appointed master mechanic of the Maryland-Delmarva division of the Pennsylvania, with headquarters at Wilmington, Del.

BETHEL MANLEY has been appointed road foreman of engines of the Southern at Birmingham, Ala.

Electrical

D. B. THOMPSON, mechanical and electrical engineer of the New York Central at New York, has retired.

HARRY W. WALSH, assistant mechanical and electrical engineer of the New York Central, has been appointed mechanical and electrical engineer, with headquarters at New York.

RICHARD P. TOUSSAINT, assistant engineer of the New York Central, has been appointed assistant mechanical and electrical engineer, with headquarters at New York.

W. K. BOULDIN, electrical foreman at the Roanoke, Va., shops of the Norfolk & Western, has retired.

HARRY F. BROWN, electrical engineer of the New York, New Haven & Hartford, has retired.

A. H. EDMONDS has been appointed electrical foreman at the Roanoke,, Va., shops of the Norfolk & Western. Mr. Edmonds was previously assistant electrical foreman.

J. E. HUDDLESTON has been appointed assistant electrical oreman at the Roanoke, Va., shops of the Norfolk & Western.

Obituary

H. E. WAGNER, master car builder of the ALTON & SOUTHERN, died November 6, in St. Louis.

In the LONG RUN...
Truarc Retaining Rings
Resilient Stop Plates Prevent Axle Scoring
Easily Replaceable Unit Wick Set
Patented and Patents Pending
IT COSTS LESS TO LUBRICATE WITH MODERN
FELPAX Lubricators
Here's Why...
Maintenance reduced to a minimum of periodic checking and filling the oil sump.
Special Felt Wicks last thousands of miles without attention and eliminate waste grabs.
New, Improved Construction simplifies replacing worn out wicks. Inexpensive replacement kits make reconditioning of lubricators a fast, simple operation.
ON "HOT-SHOT" or "LOCAL"—you can be sure every journal is getting full continuous lubrication when modern FELPAX Lubricators are in each axle cap. Waste grabs and starved bearings due to improper packing of old fashioned yarn are eliminated. Special Felt Wicks in constant contact with the journal provide full, continuous lubrication from the first turn of the axle.
For Full Information about Modern FELPAX Lubricators see your locomotive builder or write to:
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WINONA, MINNESOTA
MILLER FELPAX LUBRICATOR